Intelligent Parameter Monitoring System

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Gautam Buddh Technical University

JUNE - 2013

Declaration

We hereby declare that this submission is our own work and that, to the best of our knowledge and belief, it contains no material previously published or written by another person nor material which to a substantial extent has been accepted for the award of any other degree or diploma of the university or other institute of higher learning, except where due acknowledgment has been made in the text.

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Certificate

This is to certify that Project Report entitled **“Intelligent Parameter Monitoring System”** which is submitted by Komal Bir Singh Khosa, Kshitij Gupta, Mansi Saxena and Mahima Singh in partial fulfillment of the requirement for the award of degree B.Tech in Department of Electronics and Communication Engineering of Gautam Buddh Technical University, is a record of the candidates own work carried out by them under my supervision. The matter embodied in this thesis is original and has not been submitted for the award of any other degree.

Head of Department	**Supervisor**
Prof. P.K.Chopra	Manish Zadoo
(Professor & HOD)	(Asst. Professor)
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We also do not like to miss the opportunity to acknowledge the contribution of all faculty members of the department for their kind assistance and cooperation during the development of the project. Last but not the least, we acknowledge our friends and all the lab assistants for their contribution in the completion of the project.

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Abstract

The project consists of ATmega32 interfaced with 3 sensors, soil moisture sensor, temperature sensor and the photo detector. These sensors perform the various tasks like monitoring the temperature and starting the alarm, keep a track of the soil moisture to turn the water pump ON/OFF and switching ON the farm lights in case of cloudy weather or during night.

The user can program the µC before connecting it in the circuit by the use of the embedded circuit and making use of the software like CVAVR and DOCKLIGHT. The temperature sensor LM35 can be programmed for the temperature threshold value. The remaining model is also reprogrammable. The language used is C.

The working is demonstrated by using normal 230V supply. In order to display the results a 16x2 LCD is also provided which displays the LM35 measured value, soil moisture content and also the photo detector value. Just in case extra power supply is required at the farm, solar panel is also installed to store the energy in the batteries to retrieve it in future.

India is basically an agricultural country and in order to increase the yield of the seasonal crops, some modern technologies need to be used. This model is a prototype for such set up. Since initial cost can be high so few farmers can implement it on the shared basis.

It will definitely improve the productivity and also the quality of the agro-product.

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List of Abbreviations

S.No.	Abbreviation	Full Form
1.	μC	Microcontroller
2.	ADC	Analog to Digital Converter
3.	PCB	Printed Circuit Board
4.	IC	Integrated Circuit
5.	RISC	Reduced Instruction Set Computing
6.	MUX	Multiplexer
7.	LCD	Liquid Crystal Display
8.	LED	Light Emitting Diode
9.	CLK	Clock
10.	SPI	Serial Peripheral Interface

Chapter 1: Introduction

1.1 Project Introduction:

India is Agro based nation. Agriculture has always imparted a lion's share in the economic development of country. It is necessary to improve the productivity and quality of agro based products. Technology will boost the development in agriculture. And with the use of the presented model we can even monitor certain other parameters like soil moisture, temperature and the intensity of the day light.

The continuous increasing demand of food requires the rapid improvement in food production technology. In a country like India, where the economy is mainly based on agriculture and the climatic conditions are isotropic, still we are not able to make full use of agricultural resources. The main reason is the lack of rains & scarcity of land reservoir water. The continuous extraction of water from earth is reducing the water level due to which lot of land is coming slowly in the zones of un-irrigated land. Another very important reason of this is due to unplanned use of water due to which a significant amount of water goes to waste.

1.2 Automating crop watering:

Most of the farmers use manual system to water their crops in the farm, this system is inefficient. When we water manually, the possibility to over watering is high. Some crops can drown when we supply too much water to them. In order to overcome this problem, automatic watering system is used. Sensor such as soil moisture detector is used to control the watering system.

There are many cases when it is inconvenient, if not impossible, to expertly irrigate without automation. For example, dedicated labor may not be available to operate drip systems frequently (multiple times per week or even per day) and for short durations of time, which in many cases is the ideal to maximize yields and avoid wasting water and fertilizer. Growers who automate find that controllers and valves are cost effective and reliable, leaving labour to perform other, more important tasks to grow a better crop.

1.3 Today's scenario:

In today's world due to global warming and climate changes there is challenging situation in field of agriculture. Number of advanced methods and technologies are coming in agriculture to reduce cost and improve total productivity. Water is an important resource in agriculture. There is new concept of agriculture in controlled environment. This report concentrate on measuring temperature, moisture content and controlling water supply depending on moisture content of soil.

The development of agriculture in terms of area of land under cultivation, use of modern equipment and financial assistance to the farmers is absolutely essential. One of the major problems present today is the less knowledge of the soil content, the irrigation amount.

The technological development in Sensor Networks made it possible to use the sensors in monitoring and control of agriculture parameters in rural area. Due to uneven natural distribution of rain water it is very crucial for farmers to monitor and control the equal distribution of water to all crops in the whole farm or as per the requirement of the crop.

There is no ideal irrigation method available which may be suitable for all weather conditions, soil structure and variety of crops cultures. It is observed that farmers have to bear huge financial loss because of wrong prediction of weather and incorrect irrigation method to crops. With the evolution in electronics, now it is possible to measure the important parameters and to take the actions accordingly.

1.4 Basic structure of the project:

The circuit comprises of sensor parts built using the Microcontroller (ATmega32). μC is used to control the whole system as it monitors the sensors.

- When the soil moisture sensor sense the dry condition then the microcontroller will switch ON the motor and it will switch off the motor when the sensor is in wet.
- Similarly, in the case of the temperature sensor, when the temperature sensor senses a high temperature in case of fire outbreak (here 55 degree Celsius), it raises the alarm and opens the door of the animal barn for the animals to escape.
- A photo detector is also installed in the model to cater for the increasing demand of the energy. It receives sunlight during the day time and charges the batteries connected to it. These batteries can be used to light the farm lights during night or on a cloudy day.

The microcontroller does the above job by receiving the signals from the sensors, and these signals are operated under the control of software which is stored in ROM.

We provide a new technology for automation of agriculture field by avoiding the wastage of water which occurred in the older irrigation system. Furthermore, this project can scale down the manpower requirements to a larger magnitude. The project presented here waters plants automatically and regularly as per the soil moisture content. In this setup, copper wires are inserted in the soil, which function as sensors for detecting the soil moisture content.

An integrated Liquid crystal display (LCD) is also used for real time display of data acquired from the various sensors.

1.5 Objectives of the project:

The major objectives of developing this project are:

- To study some of the important parameters such as soil moisture content, temperature determination to prevent fire condition and storing solar energy for lighting the farm at night.
- To adopt technique for controlling the agricultural parameters.
- To use different sensors to sense the field parameters.
- To collect and transmit the information using Embedded System and even displaying the data on the LCD.
- To use the microcontroller to receive the information and perform the needful controlling action.
- To design the module which is useful in rural development.
- To obtain the readings, observations and providing the facility to store the data for future use.
- To measure the performance and provide all possible benefits to the farmers.

1.6 Benefits of the project:

- This report would take the opportunity to design an instrument that is able to monitor the ambient temperature, soil moisture and intensity of light in an agriculture environment.
- This project aims to demonstrate the use of technology and data visualization as the basis for the critical problems, challenges and future goals of development and applications.
- Modern agricultural management relies strongly on many different sensing methodologies to provide accurate information on crop, soil, climate and environmental conditions. Almost every sensing technique may find an application in agriculture.
- Smart sensors continuously collect data over wide areas of agriculture field. They are particularly useful for agriculture where current methods of data collection typically involve one-off surveys that are infrequent, labour intensive and expensive.

- Sensor networks can provide real-time measurements of parameters such as:

  (a) Soil moisture
  (b) Temperature
  (c) Sunlight

1.7 Introduction to the Sensors used:

Inexpensive sensor technologies are increasingly being used in modern agriculture to provide real-time information on soil and meteorological conditions.

1.7.1 Soil moisture probes:

Soil water affects the crop growth. Therefore, the monitoring & controlling soil condition has a specific interest, because good condition of a soil may produce the proper yield. The proper irrigation and fertilization of the crops are varied as per the type, age, phase and climate. The moisture can be controlled by the irrigation techniques like sprinkler system.

A number of different methods are used for measuring humidity in soil. The choice of the most suitable method is usually made by the user based on the local situation. The use of a simple but correctly applied humidity measuring device often permits achieving a better accuracy or meeting the particular requirements. Using soil moisture measurements is one of the best and simplest ways to get feedback to help make improved water management decision.

Soil moisture measurements can provide information on plant water availability, but these data are not regularly collected. However, a growing number of inexpensive soil moisture sensors are available for use in farm fields to provide information on current conditions.

Soil moisture is also of paramount importance in developing agricultural management strategies (e.g., irrigation) and predicting crop yield, as well as detecting and monitoring drought. Water stress, induced by limited water availability, is perhaps the biggest factor in reducing crop yield.

Depending on the measured value of the soil moisture, the water pump is either switched ON or OFF by the microcontroller.

1.7.2 Temperature sensor:

The temperature sensor used here is LM35 and it is used to keep a check on the surrounding temperature level.

When the temperature rises above the threshold level then the gate of the animal barn is opened for the animals to escape in case of fire and also it starts a buzzer which acts like a fire alarm for the farm workers.

Temperature sensors come in many different forms and are used for a wide variety of purposes, from simple home use to extremely accurate and precise scientific use.

1.7.3 Photo detector:

A photo detector is used in the model to demonstrate the use of the solar panels for the lighting purpose. The photo detector here detects the sunlight and in case sufficient light is not available for working, the lights around the farm, which are connected to batteries charged by solar panel, are switched ON. In the model, it is shown by the LED glowing near the relay.

Thus, it is an alternative to using the costly power supply.

1.8 Solar panel:

The high efficiency solar farm lights are being used, which operate as one integrated system, including power generation, storage and management. They are easy to install and eliminate the need for trenching and grid connection. Solar panels charge a battery and this energy is used to power the lamp during the night.

These sensors automatically organize themselves into an ad-hoc network, which means they do not need any preexisting infra-structure. They have decisive advantages, compared with the technologies previously used to monitor environments via the collection of physical data.

In this, the potential of sensor networks are explored in an original context, the agriculture of rural area. The goal is to confront an emerging technology with a concrete problem of world-wide dimensions, the sustainability of farming for land-holders living in rural area.

1.9 Microcontroller and ADC:

The microcontroller used here is ATmega32 and its datasheet has been included in the appendix of the report. The µC is the main part of the model which takes care of all the functions of the model. It receives the signals from the sensors, analyses them and takes the necessary actions accordingly.

The values passed on by the sensors are analog in nature and these need to be converted to digital form for µC to use them. This function is performed by the Analog to Digital Converter (ADC). Unlike the other µC like the AT89c51 or others, the ATmega32 has a built in ADC and thus it eliminates the need to connect an external ADC in the circuit.

This simplifies the circuit and hence reduces the jumpers on the PCB.

Chapter 2: Equipment Specification

2.1 Power supply:

The System Uses +15V regulated power supply. Step down transformer is used to step down mains voltage to 15V. Transformer provides current up to 500mA.

Power supply consists of a transformer, bridge rectifier, and voltage regulating IC 7805. +5 V, -5V, +15V DC power supply is designed to provide VCC as well as reference voltage to the various ICs.

Power supply design has following stages:-

2.1.1 Step down transformer (230V/220V to 15V AC):

Here, step down transformer converts 230V from AC mains into 15V AC. Transformer steps down ac voltage from 230v ac to 15v ac. It is then given to bridge rectifier. Bridge rectifier converts ac voltage into pulsating dc. It is then given to regulator IC which output constant dc voltage. These voltages are given to other ICs as VCC or reference. Outputs of IC 7805 is +5V.

2.1.2 Bridge rectifier:

Rectifier converts ac voltage into dc voltage. 4 diodes are connected in bridge. Its input is from transformer and output is given to the voltage regulator IC.

2.1.3 Voltage Regulator IC:

Voltage regulator IC gives constant DC voltage of 5V at output in spite of fluctuations in input.

2.2 Voltage regulator:

The voltage regulator IC used here is 7805 and it provides a constant dc voltage of 5V i.e. it removes all the fluctuations from the input to give a constant output.

2.2.1 Other specifications:

- terminal regulator
- Output current up to 1.5mA
- Internal thermal-overload protection
- High Power-Dissipation Capability

- Output Transistor Safe-Area Compensation

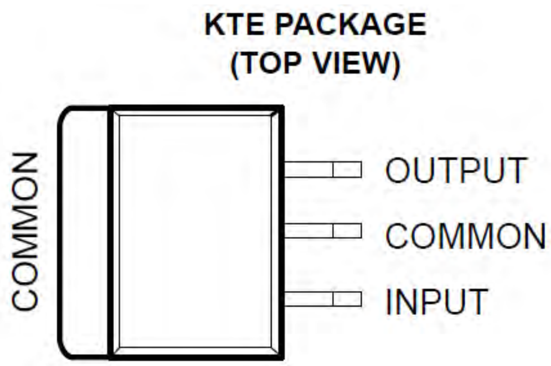


Fig 2.1: Top View of KTE Package Voltage Regulator

2.2.2 Description/ordering information

This series of fixed-voltage integrated-circuit voltage regulators is designed for a wide range of applications. These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation. Each of these regulators can deliver up to 1.5 A of output current.

The internal current-limiting and thermal-shutdown features of these regulators essentially make them immune to overload. In addition to use as fixed-voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents, and also can be used as the power-pass element in precision regulators.

2.3 Microcontroller (ATmega32):

2.3.1 Pin configuration:

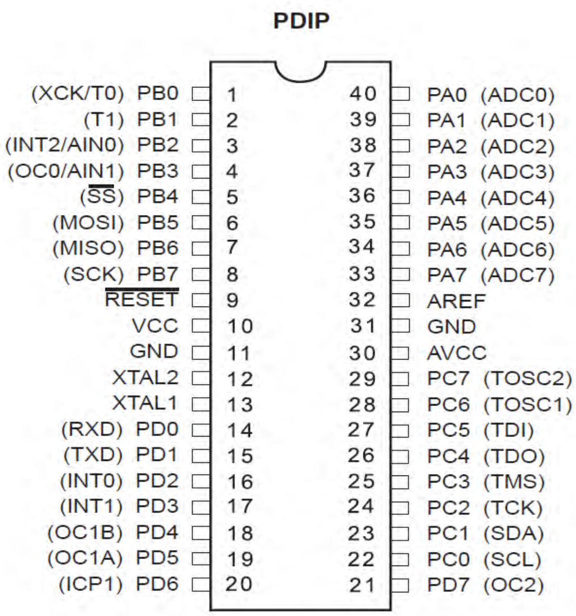


Fig 2.2: Pin Configuration of Atmega32

2.3.2 Overview:

The Atmel AVR ATmega32 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega32 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

2.3.3 Features:

High-performance, Low-power Atmel® AVR® 8-bit Microcontroller

2.3.3.1 Advanced RISC Architecture

- 131 Powerful Instructions – Most Single-clock Cycle Execution
- 32 x 8 General Purpose Working Registers
- Fully Static Operation
- Up to 16 MIPS Throughput at 16 MHz
- On-chip 2-cycle Multiplier

2.3.3.2 High Endurance Non-volatile Memory segments

- 32Kbytes of In-System Self-programmable Flash program memory
- 1024Bytes EEPROM
- 2Kbyte Internal SRAM
- Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
- Data retention: 20 years at 85°C/100 years at 25°C
- Optional Boot Code Section with Independent Lock Bits
- In-System Programming by On-chip Boot Program
- True Read-While-Write Operation
- Programming Lock for Software Security

2.3.3.3 JTAG (IEEE std. 1149.1 Compliant) Interface

- Boundary-scan Capabilities According to the JTAG Standard
- Extensive On-chip Debug Support
- Programming of Flash, EEPROM, Fuses, and Lock Bits through the JTAG Interface

2.3.3.4 Peripheral Features

- Two 8-bit Timer/Counters with Separate Prescalers and Compare Modes
- One 16-bit Timer/Counter with Separate Prescaler, Compare Mode, and Capture Model.
- Real Time Counter with Separate Oscillator
- Four PWM Channels
- 8-channel, 10-bit ADC

2.3.3.5 8 Single-ended Channels

2.3.3.6 7 Differential Channels in TQFP Package Only

2.3.3.7 2 Differential Channels with Programmable Gain at 1x, 10x, or 200x

2.3.3.8

- Byte-oriented Two-wire Serial Interface
- Programmable Serial USART
- Master/Slave SPI Serial Interface
- Programmable Watchdog Timer with Separate On-chip Oscillator
- On-chip Analog Comparator

2.3.3.9 Special Microcontroller Features

- Power-on Reset and Programmable Brown-out Detection
- Internal Calibrated RC Oscillator
- External and Internal Interrupt Sources
- Six Sleep Modes: Idle, ADC Noise Reduction, Power-save, Power-down, Standby and Extended Standby

2.3.3.10 I/O and Packages

- 32 Programmable I/O Lines
- 40-pin PDIP, 44-lead TQFP, and 44-pad QFN/MLF

2.3.3.11 Operating Voltages

- 2.7V - 5.5V for ATmega32L
- 4.5V - 5.5V for ATmega32

2.3.3.12 Speed Grades

- 0 - 8MHz for ATmega32L
- 0 - 16MHz for ATmega32

2.3.3.13 Power Consumption at 1 MHz, 3V, 25·C

- Active: 1.1mA
- Idle Mode: 0.35mA
- Power-down Mode: < 1µA

2.3.4 Block diagram:

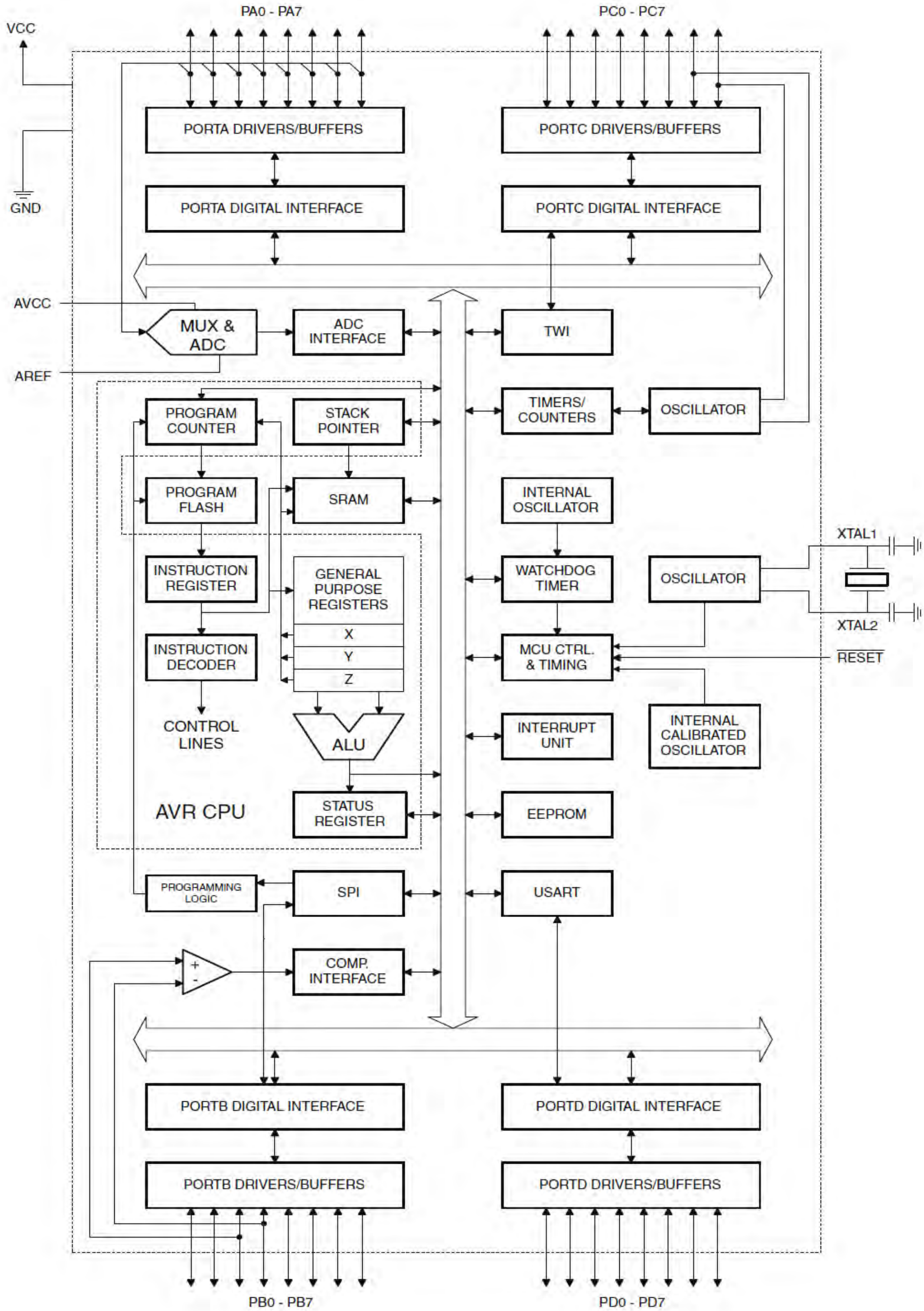


Fig 2.3: Block Diagram of ATmega32

2.4 Display device (16x2 LCD):

The display device used here is the 16x2 LCD. It is used to display the values for the various parameters which are measured by the temperature sensor, soil moisture sensor and the photo detector. These values can be used by the farmers for taking the necessary actions like watering of plants, record keeping or sending to a distant user through the satellite i.e. using the internet.

2.4.1 LCD pin diagram:

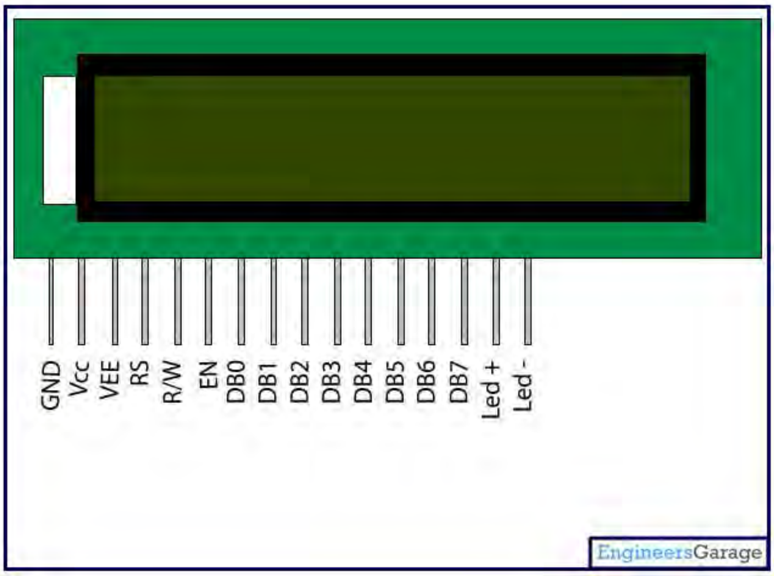


Fig 2.4: Pin Diagram of LCD

2.5 Relays and ULN2003:

2.5.1 Relays:

A **relay** is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. Because a relay is able to control an output circuit of higher power than the input circuit, it can be considered, in a broad sense, to be a form of an electrical amplifier.

2.5.1.1 Types of relays on the basis of pole and throw:

2.5.1.1.1 SPST - Single Pole Single Throw: These have two terminals which can be switched on/off. In total, four terminals when the coil is also included.

2.5.1.1.2 SPDT - Single Pole Double Throw: These have one row of three terminals. One terminal (common) switches between the other two poles. It is the same as a single change-over switch. In total, five terminals when the coil is also included.

2.5.1.1.3 DPST - Double Pole Single Throw. These have two pairs of terminals. Equivalent to two SPST switches or relays actuated by a single coil. In total, six terminals when the coil is also included. This configuration may also be referred to as DPNO.

The contacts can be either **Normally Open (NO)**, **Normally Closed (NC)**, or **change-over (CO)** contacts.

2.5.2 ULN2003:

The ULN2003 is high voltage, high current Darlington arrays each containing seven open collectors Darlington pairs with common emitters. Each channel rated at 500mA and can withstand peak currents of 600mA. Suppression diodes are included for inductive load driving and the inputs are pinned opposite the outputs to simplify board layout.

2003A is supplied in 16 pin plastic DIP packages with a copper lead frame to reduce thermal resistance.

2.5.2.1 Internal diagram:

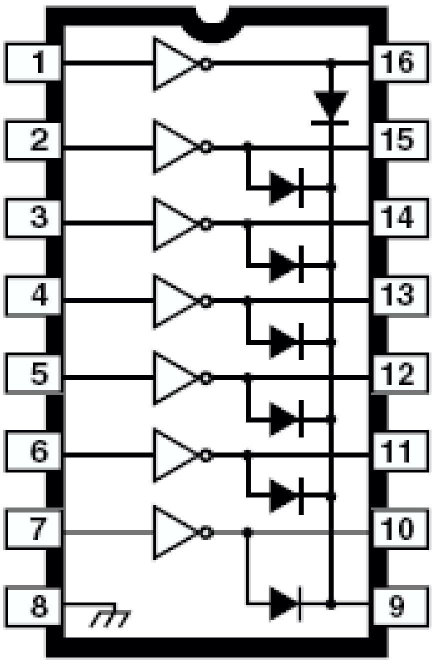


Fig 2.6: Internal Diagram of ULN2003

2.6 Sensors:

Each sensor is provided with a variable resistance of 10k.

2.6.1 Temperature sensor (LM35):

The temperature sensor here is connected to the animal barn and thus if the temperature rises above a certain level, which may be in case of fire breakout, the gate of the barn is opened for the animals to escape.

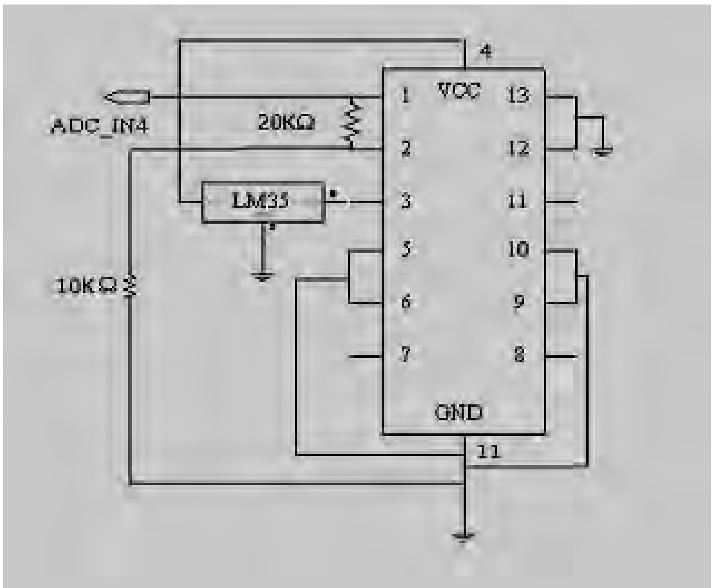


Fig 2.7: Temperature Sensor (LM35)

2.6.2 Soil moisture sensor:

The soil moisture sensor used here are actually the probes which indicate whether the moisture content is present in the soil or not. If there is no moisture content then the water pump is turned ON otherwise it is turned OFF.

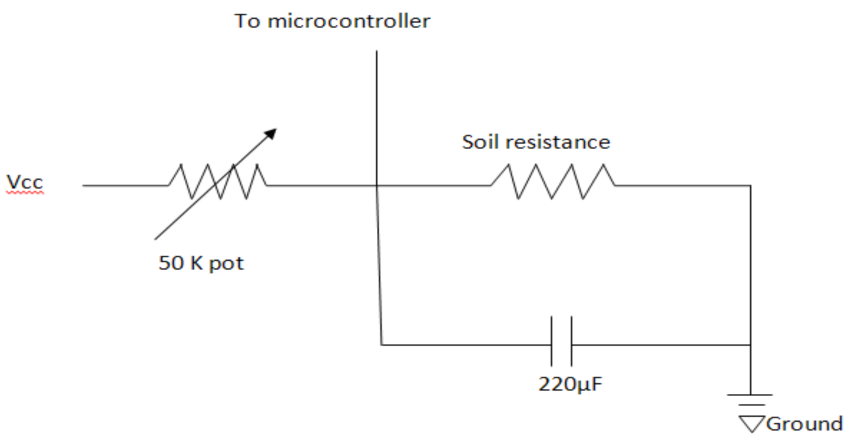


Fig 2.8: Circuit Diagram of Soil Moisture Sensor

2.6.3 Photo detector:

The photo detector is used here to turn ON the farm lights as and when required. Like in case if there is no sun then the energy stored during the day time can be used at night or in case the weather is cloudy.

This provides a cleaner approach towards generating the energy. This energy can also be used for running other farm equipment like motor etc. This saves money and also provides energy at all times.

Chapter 3: Working

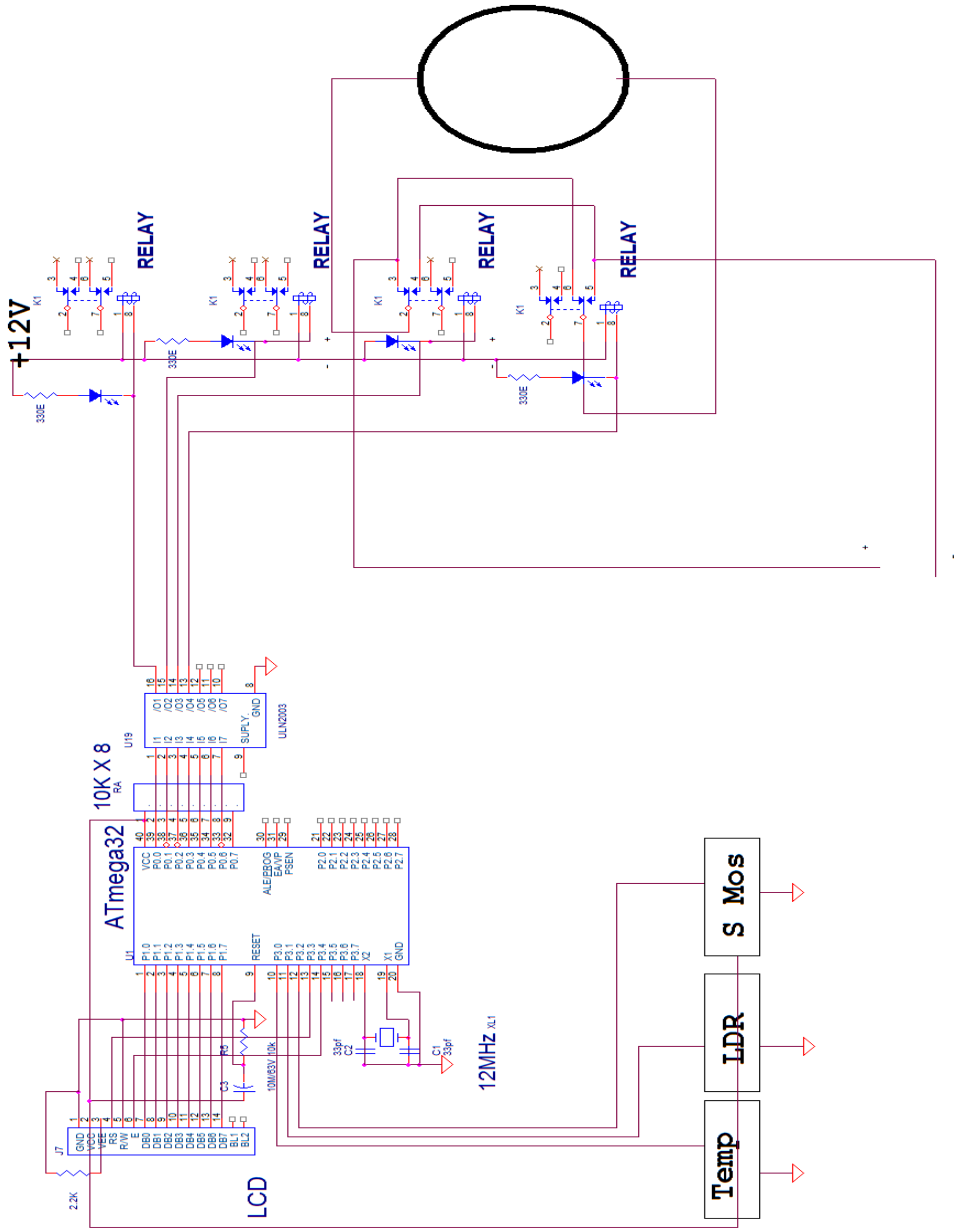


Fig 3.1: Circuit Diagram of the Proposed Project

The programming of the microcontroller is done through the keyboard connected to it and using the CVAVR software.

Three sensors are used in this project:

- Temperature sensor (LM35)
- Soil moisture sensor (probes)
- Photo detector

LM35 gives the surrounding temperature in degree Celsius. The soil moisture probe and photo detector give the output in voltage. All the three value are displayed on the LCD.

Thus, the required necessary information can be given as an output to the LCD for display which can be used by the user for taking necessary actions.

3.1 Temperature sensor:

The temperature sensor here is used to sense the environment temperature so that when the temperature rises above a certain value like in case of fire, the gate of the barn can be opened so that the animals can run out. The sensor used is LM35.

3.2 Soil moisture sensor:

This is used to sense the moisture content in the fields so that if the moisture content goes below a particular level, the water pump is turned ON. The pump can be turned OFF in case the moisture is present in adequate amount during the rainy season. The value of the moisture content is displayed on the LCD. For sensing the moisture two probes are used which show value 0V when shorted.

3.3 Light sensor:

This sensor (basically a LDR or a photo detector) is used to automate the lighting system in the farmhouse. The light sensor keeps the low signal till the light falls on it during the daytime. In the night when there is no light the circuit turns on as the resistance of LDR decreases and the current flows. Hence the farm lights can be turned ON. The light intensity value can be seen on the LCD.

3.4 Power supply:

- The System Uses +15V regulated power supply.
- Step down transformer is used to step down mains voltage (220 or 230V) to 15V.
- Transformer provides current up to 500mA.
- Bridge Rectifier is used.
- Filter capacitor is used for removing ripples present at the output of bridge rectifier.
- IC 7805 provides regulated +5V dc output voltage.

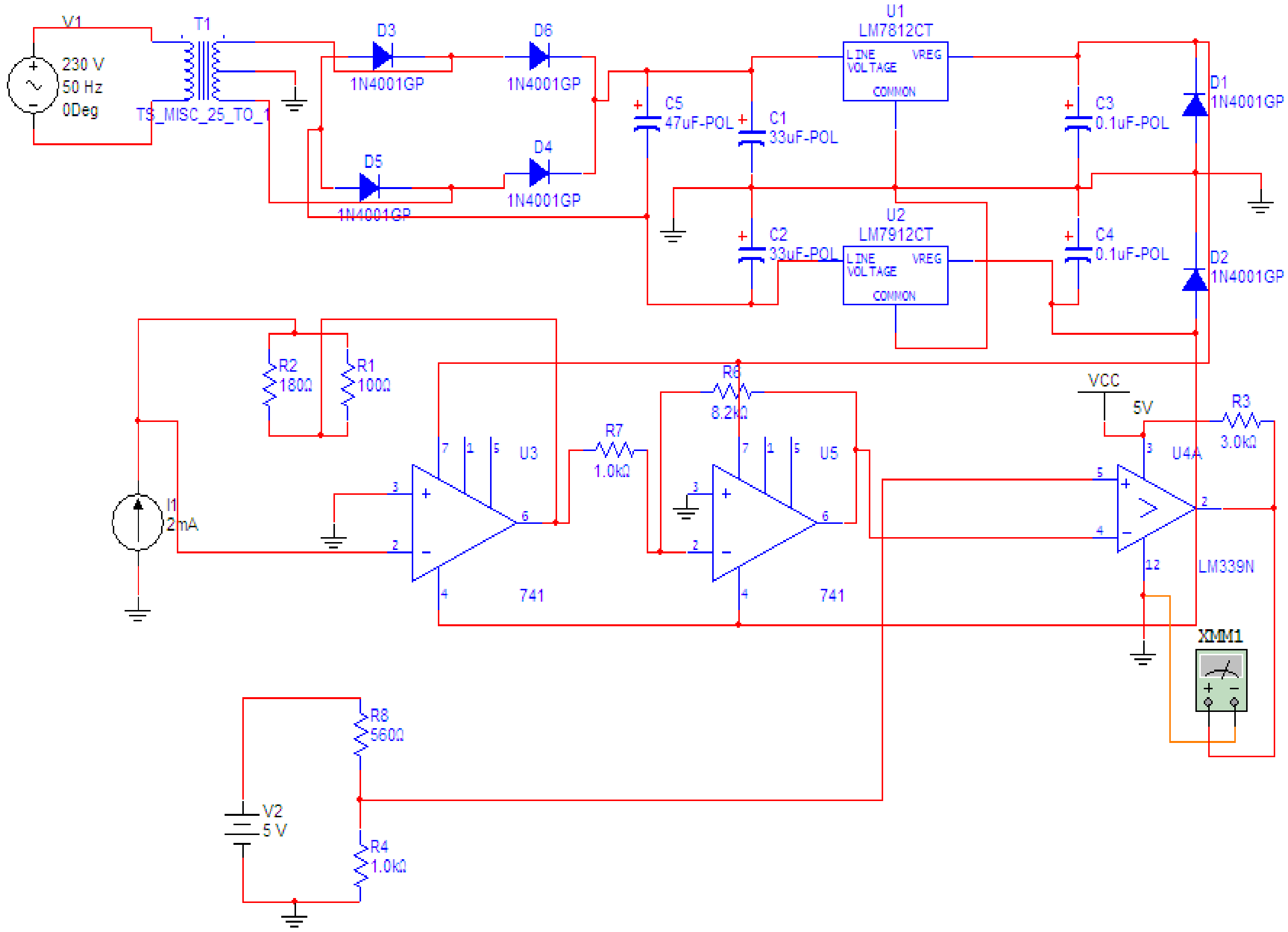


Fig 3.2: Power Supply Design in Multisim

3.5 Voltage Regulator:

The voltage regulator used here is 7805. It converts the 15V of supply coming from the step down transformer to 5V. When the supply flows from the power supply to the voltage regulator part then first it passes through a capacitor of 1000µF which removes the ripple from the supply. Then after passing through the voltage regulator, the capacitor of 1000µF is used to stabilize the supply. A LED is also put in the circuit to show the flow of 5V in the circuit.

Here in this part we have,

Current (I): 10-15mA

Voltage (V): 5V

Thus, the resistance will be around (R=V/I) : 0.5kΩ - 0.33kΩ

The internal block diagram of the voltage regulator is as shown below:

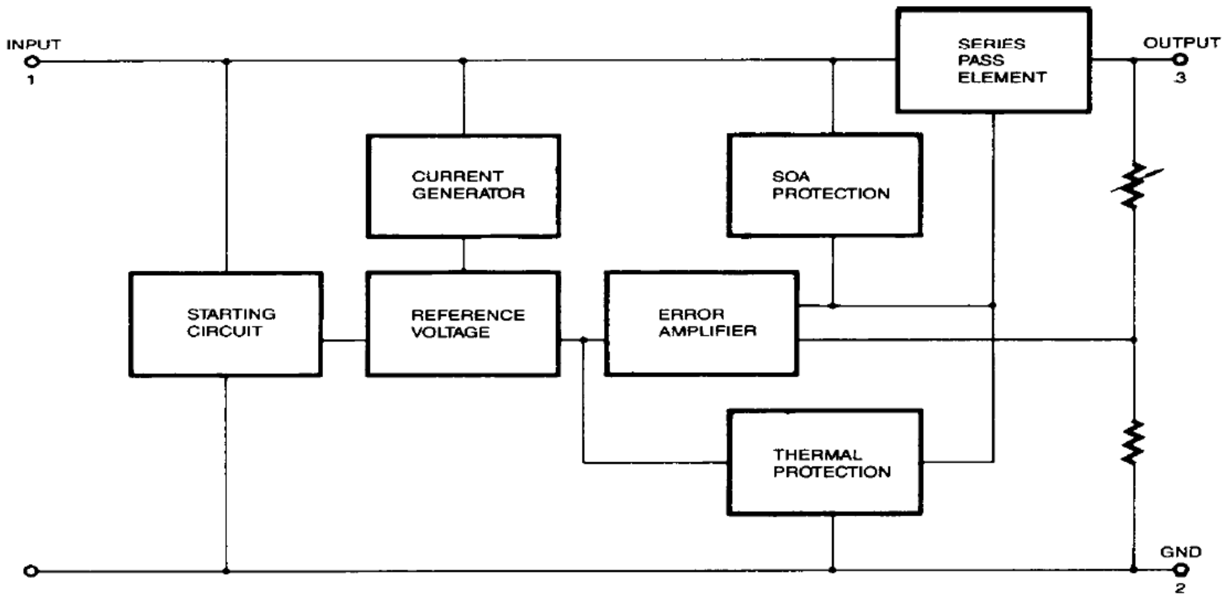


Fig 3.3: The Internal Block Diagram of the Voltage Regulator

3.6 Microcontroller:

The entire automation of the project is done by the microcontroller. All the programs are written in the microcontroller and the results are obtained. Programming is done in assembly language. Microcontroller used here is ATMEGA 32.

It is Central Processing Unit of system. It monitors all input and take corresponding action. ATmega32 Microcontroller used here has several features as follows:

- High-performance, Low-power AVR® 8-bit Microcontroller
- 32 Kbytes of In-System Self-programmable Flash program memory
- 1024 Bytes EEPROM
- Kbytes Internal SRAM
- Write/Erase Cycles: 10,000 Flash/100,000 EEPROM
- 8-channel, 10-bit ADC
- Byte-oriented Two-wire Serial Interface.

3.7 Display device (16 x 2 LCD):

Here we are using 16X2 LCD as the display device.
Following are its features:

- It can show 16 characters in 1st line and 16 characters in 2nd line.
- A 10kΩ potentiometer is used for contrast control.

- It has three control lines connected to port D of microcontroller.
- 8 Data lines are used for transferring data from microcontroller to LCD. These data lines are connected to port D of microcontroller.

The heart of circuit is controller. To fulfill different requirements we need a microcontroller which will provide compact design and requires less hardware. ATMEGA32 provides inbuilt ADC port PAX which is used for sensors interface.

3.8 Solar panel:

A solar panel set up is done on the boundary of the farm house for lighting up the farm. Batteries may be connected to the solar panels for storing the energy during the day time. This stored energy can be used to turn ON the lights at night. This will help reduce the electricity cost.

The model type used here is: 3W

The general specifications for this model include:

- Nominal maximum power (Pmax) : 3W
- Optimum operating voltage (Vmp) : 8.82V
- Optimum operating current (Imp) : 0.34A
- Open circuit voltage (Voc) : 10.80V
- Open Short circuit current (Isc) : 0.38A

The main function of including solar panel is just to provide an alternative power supply.

The specifications given above are for the model presented. On a large scale, these specifications are usually much higher than this. LED are connected to the solar panel presented here. They glow when light falls on the panel.

The panel is not connected to the model physically but is just used for illustration purpose. It is so because the model presented will require a bigger solar panel with higher specifications and will make the model bulky. So the panel just shows that its bigger model can light a farmhouse in case of need.

3.9 Relays and relay driver IC ULN2003:

In the project there are 4 relays and 1 relay driver IC ULN2003. Each relay is of 12V specification with 1.2k resistance with each. There is a LED connected with each relay. These LED are used to indicate that that particular LED is working.

3.9.1 Relay:

A **relay** is an electrical switch that opens and closes under the control of another electrical circuit.

3.9.1.1 Relay 1: Used for light sensor i.e. photo detector
LED colour: Green

3.9.1.2 Relay 2: Used for soil moisture sensor (actually the probes)
LED colour: Yellow

3.9.1.3 Relay 3&4: Used for temperature sensor (LM35)
LED colour: Red and White

Two relays are used for the temperature sensor because one is required for the forward movement of the motor and other for the backward movement of the gate used for the animal barn.
Thus, LM35 is connected to the relay 3&4 so that in case when the temperature increases a certain level in case of fire, the gate can be opened.

3.9.2 ULN2003:

The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays. It is used in this model to drive the relays. Other applications include hammer drivers, Lamp drivers, display drivers (LED gas discharge), line drivers, and logic buffers.

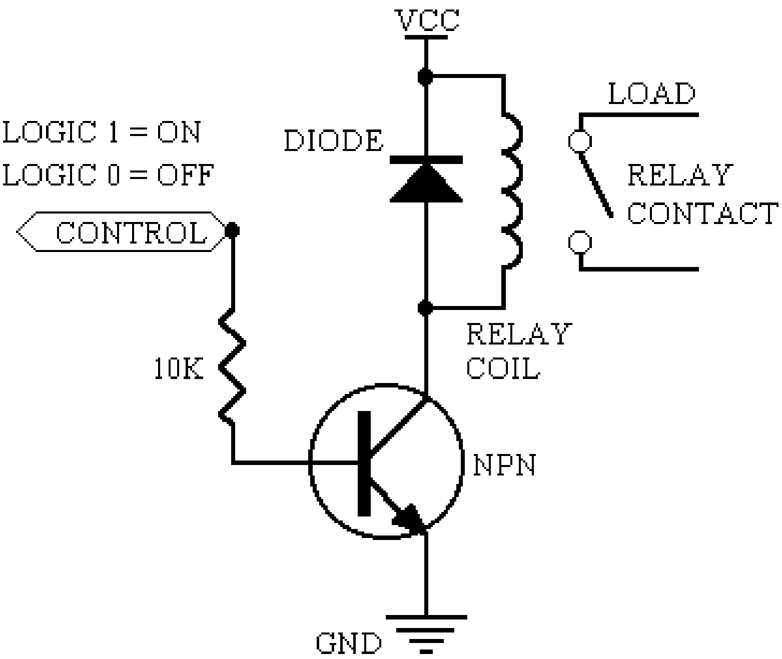


Fig 3.5: Relay Driver Circuit Diagram

3.10 Buzzer:

A buzzer is connected to the relay which is connected to the temperature sensor (LM35). When the temperature reaches an alarming level i.e. in case of fire, the animal barn gate is opened and the buzzer starts beeping.

Thus it acts like an alarm for the personnel working in the field in case of fire breakout. Thus necessary actions can be taken.
The buzzer used in this model is PIEZO BUZZER. Piezoelectric ceramic buzzer element have a simple structure in which piezo ceramic element is glued to vibration plate. When alternating voltage is applied to piezo ceramic element, the element expands or shrinks diametrically. This characteristic is utilized to make vibration plated bend to generate sounds.

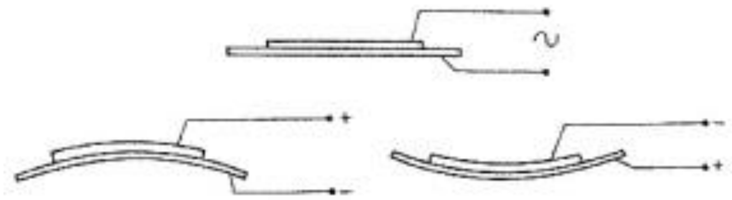


Fig 3.6: Internal Structure of the Piezo Buzzer

3.11 Brief working:

3.11.1 The supply used is a 220 V supply which is converted to 15 V by a step down transformer.
3.11.2 Then a bridge rectifier is used for ac to dc conversion
3.11.3 A 1000 µF capacitor is used as a filter to remove the ripples.
3.11.4 A voltage regulator 7805 is used to convert the voltage level from 15 V to 5 V.
3.11.5 A 1000 µF capacitor is connected in the circuit to stabilize the 5 V supply.
3.11.6 In the same circuit, 330Ω resistance (current: 15mA, voltage: 5V) is connected to glow the LED to show the 5 V supply flow.
3.11.7 Another part of the circuit has the microcontroller ATMEGA 32, a 40 pin µC.

- The pin 9 has the 10 µF + 10 K resistance to reset.
- Pin 18 and pin 19 have the crystal oscillator connected to them, producing a frequency of 4.9152 MHz.
- Pin 20 is GND and pin 40 is VCC.
- The µC has 4 ports with 8 bits each, thus a total of 32 bits.
- Port 0 is open collector, 10K resistance is provided here at pins from pin 32 to pin 39 to provide the collector current.

3.11.8 A 16x2 LCD is used to display the results.

3.11.9 ULN2003, the relay driver IC, of 16 pins, is connected in the circuit. It has pin 8 connected to GND while pin 9 is connected to VCC.

3.11.10 LEDs are used with 1.2 kΩ resistance to show the working of relays.

3.11.11 When relay is off, LED is off.

3.11.12 Each relay is of 12V each and is provided with 1.2Ω each.

3.11.13 Each of the three sensors are provided with a variable resistance of 10k each.

3.12 Block diagram:

The block diagram of the model can in general be shown as:

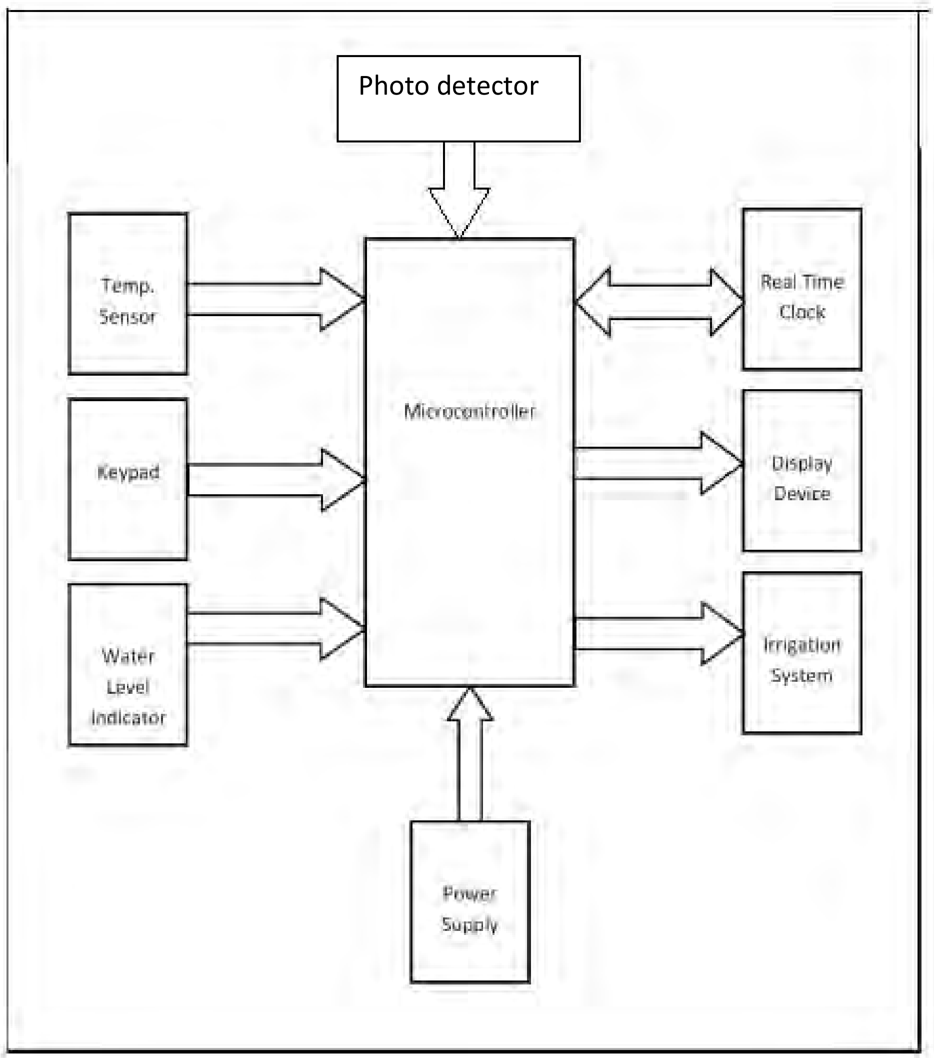


Fig 3.7: Block Diagram of the Proposed Project

Starting from the microcontroller we can see that it is the central part of the model i.e. the brain and holds the maximum importance in terms of data processing.

The real time clock is provided in the model to provide the clock pulses required by the microcontroller for the functioning.

The programming of the microcontroller is done with the help of the CVAVR software. The programming is usually done in C language but it can also be done in assembly language. For this only the keypad is provided.

The power supply comes from the 220V ac which is converted into 15V by the step down transformer. Then the 15V is converted into 5V by the voltage regulator to be used in the model.

The photo detector shown here shows the presence of the sun and helps turning on the farm lights at night when there is no light or on a cloudy day.

The temperature sensor senses the temperature and in case it rises above a certain level (may be in case of fire), the buzzer may be set on and the gate of the animal barn is opened so that the animals may be saved.

The water level detector is actually the soil moisture sensor which senses the moisture content in the soil and depending on that the pump is turned ON or OFF.

All the data is shown on the display device which is usually a LCD provided in the model. Here we are using a 16x2 LCD for displaying the values of the temperature (in Celsius), soil moisture (in volts of the potentiometer used for it) and the light intensity (also in volts not in candela).

This model is used to provide the modern means of agriculture with automation of the various services like watering of plants, switching water pump ON/OFF, turning lights ON/OFF and displaying the data for the use in future or for record purpose.

The actual model looks like this:

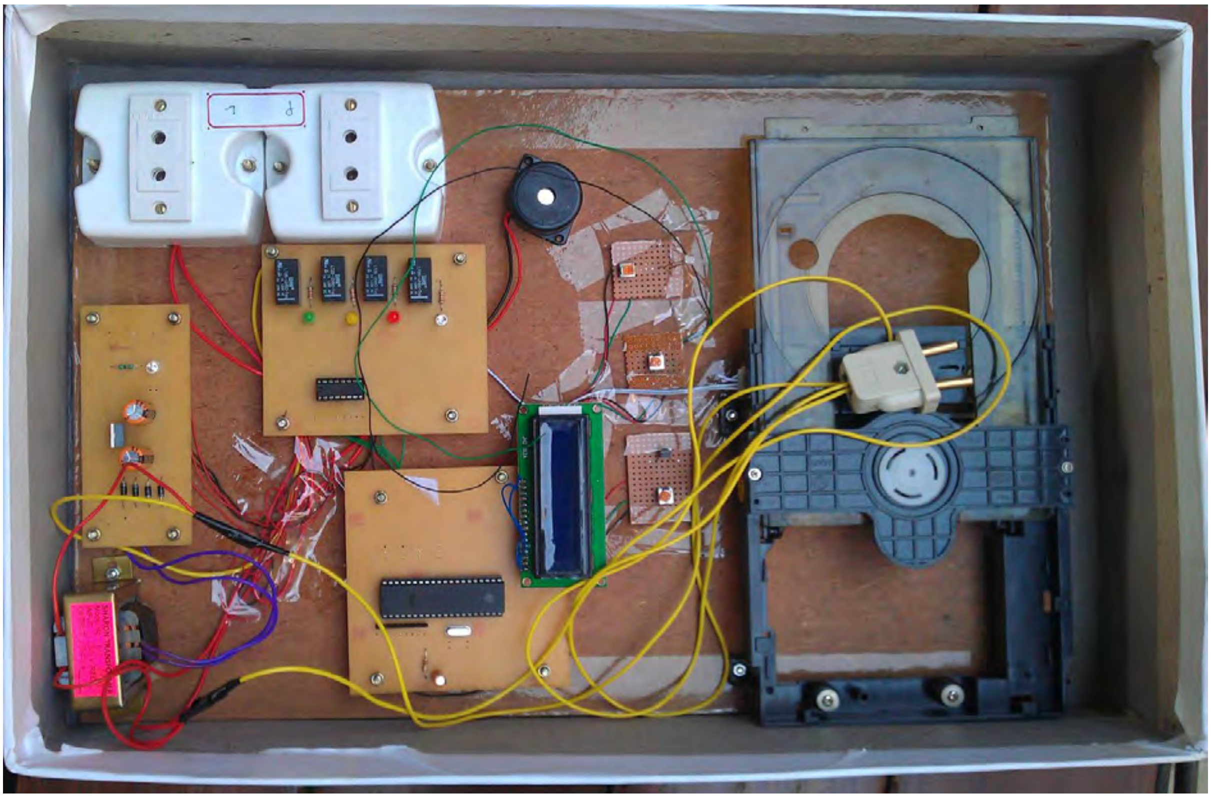


Fig 3.8: Actual Model of the Project

Chapter 4: PCB layout and Component testing

4.1 Testing of hardware:

Circuit diagram of the project that is simulated in Proteus 7.6:

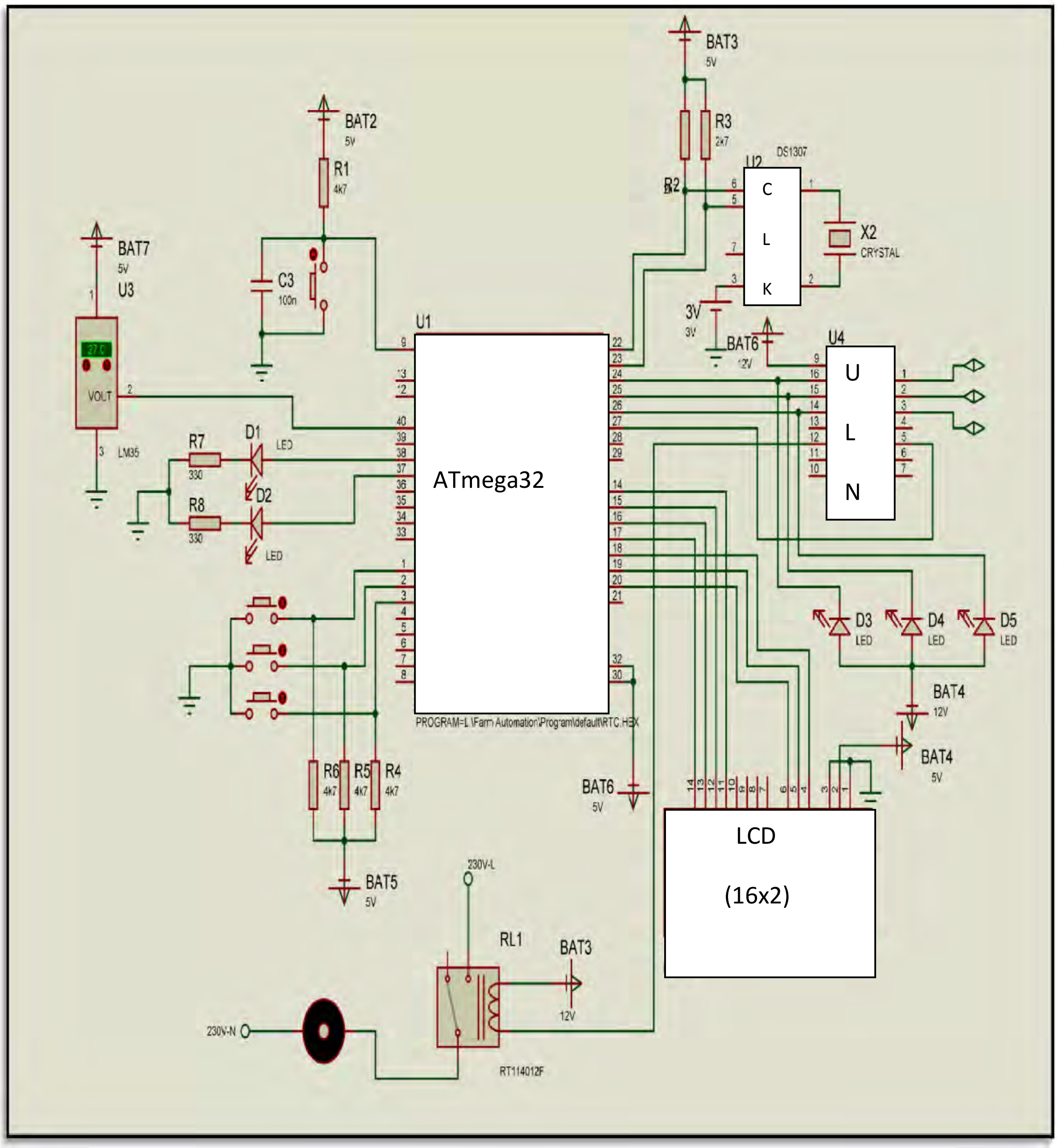


Fig 4.1: Circuit Simulation in Proteus

4.2 Debugging and testing of hardware:

- Check whether each IC and component is getting required power supply or not. This step is performed by using DMM. Vcc and common points are connected to the Vcc and Ground of components or IC's.

- Check connection of Vcc and grounds. Check if there is any short between the two supplies or the two grounds.

- Remove all jumpers. Check if each module is giving required output.

- If not then that module is faulty.

- Connect all jumpers and check the final output.

4.3 Manufacturing of PCB:

4.3.1 Printed Circuit Board (PCB):

A printed circuit board, or PCB, is used to mechanically support and electrically connect electronic components using conductive pathways, tracks or signal traces etched from copper sheets laminated onto a non-conductive substrate. When the board has only copper tracks and features, and no circuit elements such as capacitors, resistors or active devices have been manufactured into the actual substrate of the board, it is more correctly referred to as printed wiring board (PWB) or etched wiring board.

Use of the term PWB or printed wiring board although more accurate and distinct from what would be known as a true printed circuit board, has generally fallen by the wayside for many people as the distinction between circuit and wiring has become blurred.

Today printed wiring (circuit) boards are used in virtually all but the simplest commercially produced electronic devices, and allow fully automated assembly processes that were not possible or practical in earlier era tag type circuit assembly processes.

A PCB populated with electronic components is called a printed circuit assembly (PCA), printed circuit board assembly or PCB Assembly (PCBA). In informal use the term "PCB" is used both for bare and assembled boards, the context clarifying the meaning.

Printed circuit boards are used for housing components to make a circuit, for compactness, simplicity of servicing and ease of interconnection. Single sided, double sided and double sided with plated-through-hold (PYH) types of PC boards are common today.

Boards are of two types of material (1) phenolic paper based material (2) Glass epoxy material. Both materials are available as laminate sheets with copper cladding.

Printed circuit boards have a copper cladding on one or both sides. In both boards, pasting thin copper foil on the board during curing does this. Boards are prepared in sizes of 1 to 5 metre wide and upto 2 metres long. The thickness of the boards is 1.42 to 1.8mm. The copper on the boards is about 0.2 thick and weighs and ounce per square foot.

4.3.2 Advantages:

- General flexibility in circuit packaging.
- Easier component mounting.
- Reduce size and weight.
- Reduce wiring error.
- Simple troubleshooting.

4.3.3 Designing of the PCB:

The designing of PCB's consist of the designing of layout followed by preparation of artwork. The layout should include all relevant aspects and detail of PCB, while the artwork preparation bring it to form required for production process.

4.4 Manufacturing of PCB:

The simplest process on PCB fabrication involves following steps:

- Layout
- Artwork and rules
- Image transfer
- Laminate cleaning
- Etching
- Drilling
- Mounting of components
- Soldering
- Lead cutting

4.5 Materials required:

- Copper Clad Sheet
- Nail Polish or Paint
- Ferric Chloride Powder (Fecl)
- Plastic Tray
- Tap Water etc.

4.6 Procedure:

The first and foremost in the process is to clean all dirt from copper sheet with say spirit or trichloroethylene to remove traces grease or oil etc. and then wash the board under running tap water. Dry the surface with forced warm air or just leave the board to dry naturally for some time.

Making of the P.C.B. drawing involves some preliminary consideration such as thickness of lines/ holes according to the components. Now draw the sketch of P.C.B. design (tracks, rows, square) as per circuit diagram with the help of nail polish or enamel paint or any other acid resistant liquid. Dry the point surface in open air, when it is completely dried, the marked holes in P.C.B. may be drilled using 1mm drill bits. In case there is any shorting of lines due to spilling of paint, these may be removed by scraping with a blade or a knife, after the paint has dried.

After drying, 22-30 grams of ferric chloride in 75 ml of water may be heated to about 60 degree and poured over the P.C.B., placed with its copper side upwards in a plastic tray of about 15*20 cm. Stirring the solution helps speedy etching. The dissolution of unwanted copper would take about 45 minutes. If etching takes longer, the solution may be heated again and the process repeated. The paint on the pattern can be removed P.C.B. may then be washed and dried. Put a coat of varnish to retain the shine. The P.C.B. is ready.

4.7 Chemical reactions involved:

$$Fecl_3 + Cu \text{ ----- } CuCl_3 + Fe$$

$$Fecl_3 + 3H_2O \text{ --------- } Fe(OH)_3 + 3HCL$$

4.8 PCB layout:

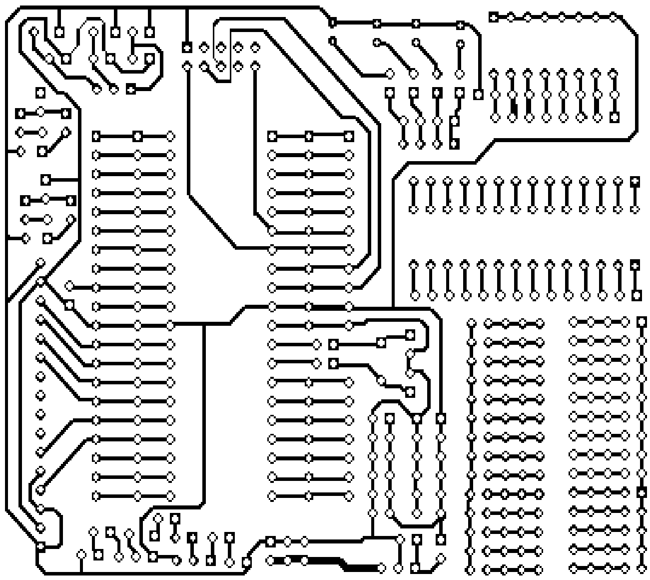


Fig 4.2: PCB Layout of the Model

4.9 Precautions:

- Add Ferric Chloride ($Fecl_3$) carefully, without any splashing. $Fecl_3$ is irritating to the skin and will stain the clothes.
- Place the board in solution with copper side up.
- Try not to breathe the vapours. Stir the solution by giving see-saw motion to the dish and solution in it.
- Occasionally warm if the solution over a heater-not to boiling. After some time the unshaded parts change their colour continue to etch. Gradually the base material will become visible. Etch for two minutes more to get a neat pattern.
- Don't throw away the remaining $Fecl_3$ solution. It can be used again for next Printed Circuit Board P.C.B.

4.10 Component testing:

4.10.1 Testing of resistor:

In a resistor we have two significant values which are taken as same as the color code chart. Third value is multiplier value, multiply with first two number values. This is the resistance value of the resistor. Forth value is of the tolerance. Now check the same resistor by multi meter, positive probe is connected to one end and negative to another.

If the multi meter shows the value, resistor is in good position and vice versa. Confirm the value is under the tolerance value.

$R = A \times 10^b \pm T$

4.10.2 Testing of capacitor:

Take the capacitor which is to be tested. The facility for testing the capacitor is provided on the DMM. Move the positive lead of the capacitor and connect to the positive probe of the DMM. Due to this capacitor goes to charge. Now move the negative lead of the capacitor and connect to the negative probe of the DMM. After this we can see that reading on DMM goes on decreasing, this means that the capacitor is in good condition & vice versa.

4.10.3 Testing of ICs:

Take the digital IC tester. Put the IC in socket of the IC tester. Input the IC no. from the keypad available on IC tester. If the IC is in good condition, it can display OK sign. Thus the IC is in good condition otherwise it is faulty.

Chapter 5: Programming

/***

Chip type : ATmega32A

Program type : Application

AVR Core Clock frequency : 4.915200 MHz

Memory model : Small

External RAM size : 0

Data Stack size : 512

***/

5.1 Program Code:

```
#include <mega32a.h>
#include <delay.h>
// Alphanumeric LCD Module functions
#include <alcd.h>
//code unsigned char msg_M1[]="BITS GSM  Meter";
 void convertanddisplay(void);
 void delay (void);
 static unsigned int ldr,soil,tmp,LOOP;
#define ADC_VREF_TYPE 0x60

// Reading the 8 most significant bits of the AD conversion result
unsigned char read_adc(unsigned char adc_input)
{
ADMUX=adc_input | (ADC_VREF_TYPE & 0xff);
```

// Delay needed for the stabilization of the ADC input voltage

delay_us(10);

// Start the AD conversion

ADCSRA|=0x40;

// Wait for the AD conversion to complete

while ((ADCSRA & 0x10)==0);

ADCSRA|=0x10;

return ADCH;

}

// Declaring global variables

void main(void)

{

// Declaring local variables

// Input/Output Ports initialization

// Port A initialization

// Func7=In Func6=In Func5=In Func4=In Func3=In Func2=In Func1=In Func0=In

// State7=T State6=T State5=T State4=T State3=T State2=T State1=T State0=T

PORTA=0x00;

DDRA=0x00;

// Port B initialization

// Func7=Out Func6=Out Func5=Out Func4=Out Func3=Out Func2=Out Func1=Out Func0=Out

// State7=0 State6=0 State5=0 State4=0 State3=0 State2=0 State1=0 State0=0

PORTB=0x00;

DDRB=0xFF;

// Port C initialization

// Func7=Out Func6=Out Func5=Out Func4=Out Func3=Out Func2=Out Func1=Out Func0=Out

// State7=1 State6=1 State5=1 State4=1 State3=1 State2=1 State1=1 State0=1

PORTC=0xFF;

DDRC=0xFF;

// Port D initialization

// Func7=In Func6=In Func5=In Func4=In Func3=In Func2=In Func1=In Func0=In

// State7=T State6=T State5=T State4=T State3=T State2=T State1=T State0=T

PORTD=0x00;

DDRD=0x00;

// Timer/Counter 0 initialization

// Clock source: System Clock

// Clock value: Timer 0 Stopped

// Mode: Normal top=0xFF

// OC0 output: Disconnected

TCCR0=0x00;

TCNT0=0x00;

OCR0=0x00;

// Timer/Counter 1 initialization

// Clock source: System Clock

// Clock value: Timer1 Stopped

// Mode: Normal top=0xFFFF

// OC1A output: Discon.

```
// OC1B output: Discon.
// Noise Canceler: Off
// Input Capture on Falling Edge
// Timer1 Overflow Interrupt: Off
// Input Capture Interrupt: Off
// Compare A Match Interrupt: Off
// Compare B Match Interrupt: Off
TCCR1A=0x00;
TCCR1B=0x00;
TCNT1H=0x00;
TCNT1L=0x00;
ICR1H=0x00;
ICR1L=0x00;
OCR1AH=0x00;
OCR1AL=0x00;
OCR1BH=0x00;
OCR1BL=0x00;

// Timer/Counter 2 initialization
// Clock source: System Clock
// Clock value: Timer2 Stopped
// Mode: Normal top=0xFF
// OC2 output: Disconnected
ASSR=0x00;
TCCR2=0x00;
TCNT2=0x00;
```

OCR2=0x00;

// External Interrupt(s) initialization

// INT0: Off

// INT1: Off

// INT2: Off

MCUCR=0x00;

MCUCSR=0x00;

// Timer(s)/Counter(s) Interrupt(s) initialization

TIMSK=0x00;

// USART initialization

// USART disabled

UCSRB=0x00;

// Analog Comparator initialization

// Analog Comparator: Off

// Analog Comparator Input Capture by Timer/Counter 1: Off

ACSR=0x80;

SFIOR=0x00;

// ADC initialization

// ADC Clock frequency: 38.400 kHz

// ADC Voltage Reference: AVCC pin

// Only the 8 most significant bits of

// the AD conversion result are used

ADMUX=ADC_VREF_TYPE & 0xff;

ADCSRA=0x87;

// SPI initialization

// SPI disabled

SPCR=0x00;

// TWI initialization

// TWI disabled

TWCR=0x00;

// Alphanumeric LCD initialization

// Connections specified in the Project|Configure|C Compiler|Libraries|Alphanumeric LCD menu:

// RS - PORTC Bit 0

// RD - PORTC Bit 1

// EN - PORTC Bit 2

// D4 - PORTC Bit 3

// D5 - PORTC Bit 4

// D6 - PORTC Bit 5

// D7 - PORTC Bit 6

// Characters/line: 16

PORTB.0=0;

PORTB.1=1;

delay();

delay();

```
delay();
PORTB.1=0;
PORTB.0=0;
lcd_init(16);
lcd_gotoxy(0,0);
lcd_puts("LDR  SOIL  TEMP ");

  PORTA.0=0;
  PORTA.1=0;
  PORTA.2=0;
  PORTA.3=0;
  LOOP=0;
while (1)
    {
     ldr= read_adc(0);
     soil= read_adc(1);
     tmp= read_adc(2);
    // code
     convertanddisplay();
     delay_us(10000);
     delay_us(10000);
     delay_us(10000);
     delay_us(10000);
        if (soil<=170)
        {
        PORTB.2=0;
```

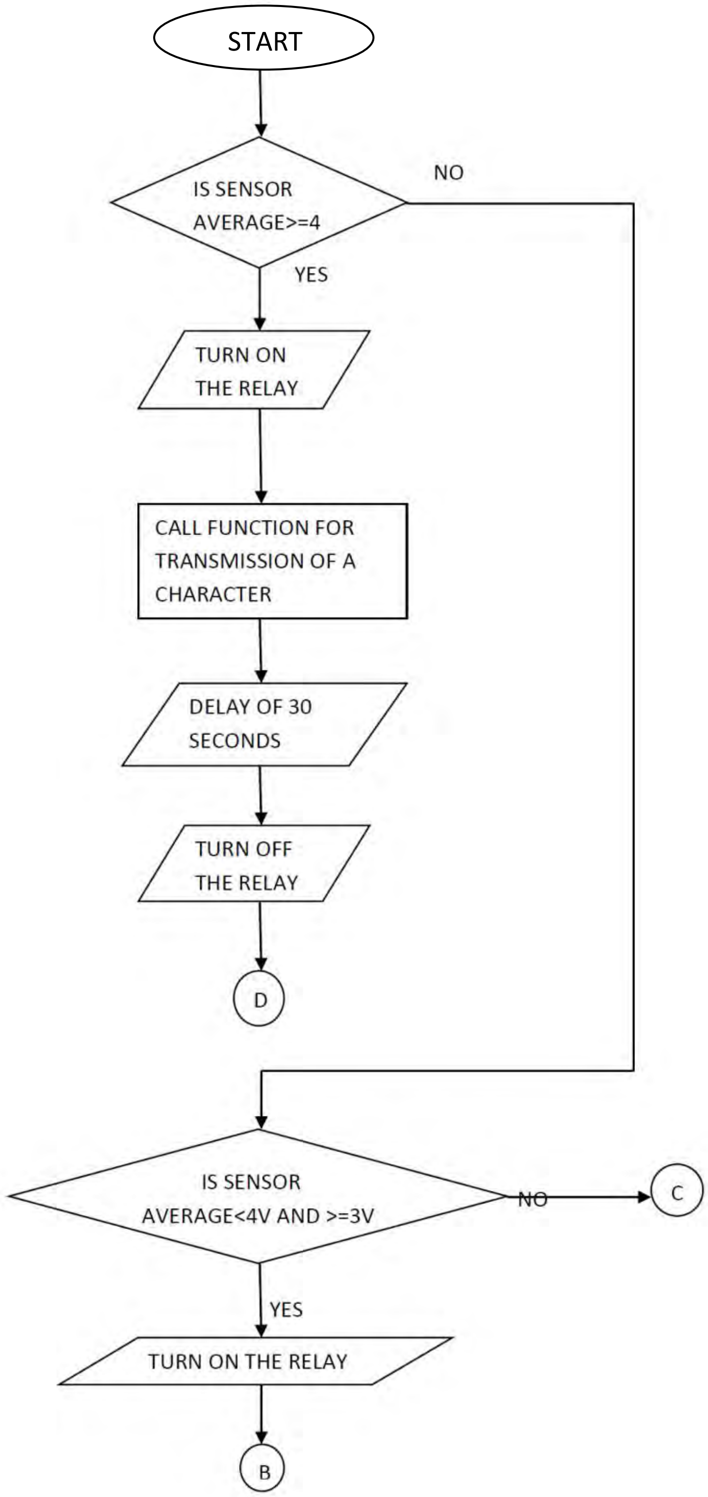
```
}
 if (soil>=200)
{
PORTB.2=1;
}
 if (ldr<=150)
{
if(LOOP==0)
{
LOOP=1;
PORTB.3=0;
   }
}
 if (ldr>=200)
{
 if(LOOP==1)
{
  LOOP=0;
PORTB.3=1;    //LED
   }
}
 if (tmp<=45-10)
{
PORTB.4=0;      //BUZZER
}
```

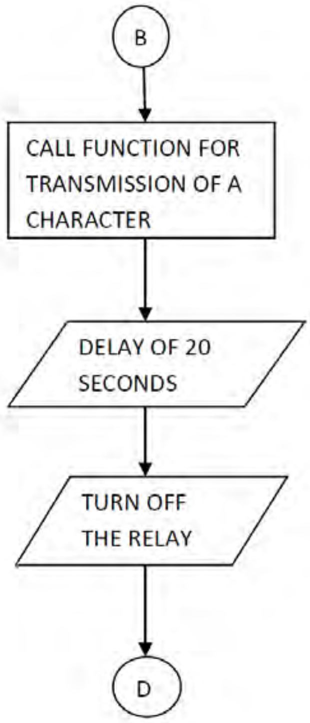
```
 if (tmp>=75-10)
{
PORTB.4=1;
 PORTB.0=1;
PORTB.1=0;
delay();
delay();
delay();
PORTB.1=0;   //MOTOR
PORTB.0=0;
}
}
}
void convertanddisplay(void)
{
unsigned int x;
unsigned char y1,y2, y3,temp;
x=ldr;
y1=x/100;

y2 = ((x/10)-y1*10);
y3=(x-(y2*10+y1*100));
lcd_gotoxy(0,1);
temp = y1+0x30;
lcd_putchar(temp);
temp = y2+0x30;
```

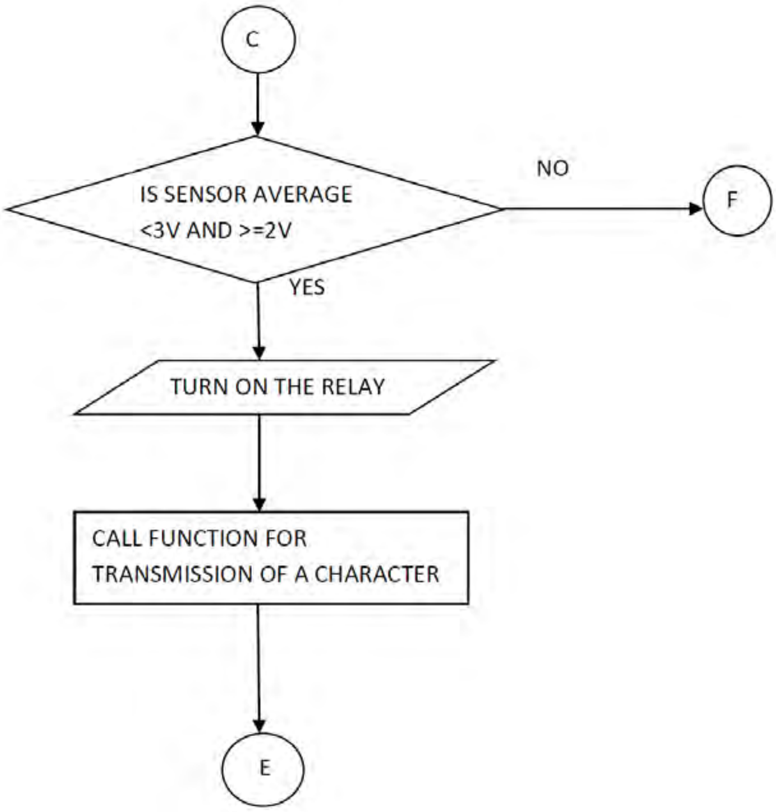
```
lcd_putchar(temp);

temp=y3+0x30;
lcd_putchar(temp);

x=soil;
y1=x/100;

y2=((x/10)-y1*10);
y3=(x-(y2*10+y1*100));

lcd_gotoxy(5,1);
temp=y1+0x30;
lcd_putchar(temp);

temp=y2+0x30;
lcd_putchar(temp);

temp=y3+0x30;
lcd_putchar(temp);

x=tmp+10;
y1=x/100;

y2=((x/10)-y1*10);
y3=(x-(y2*10+y1*100));
```

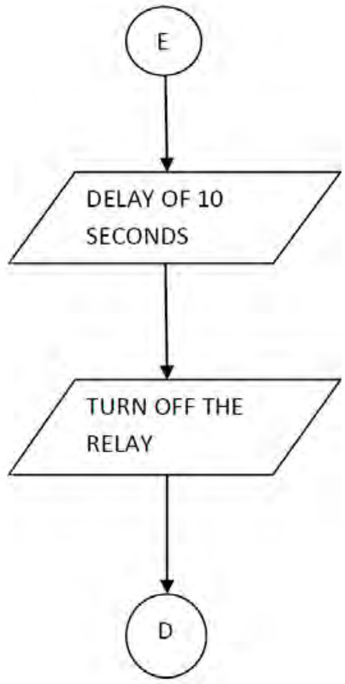
```
lcd_gotoxy(10,1);
temp = y1+0x30;
lcd_putchar(temp);

temp = y2+0x30;
lcd_putchar(temp);

temp = y3+0x30;
lcd_putchar(temp);
}

void delay (void)
  {
  unsigned int x,y;
  for (x=0;x<500;x++)
  for (y=0;y<800;y++);
  }
```

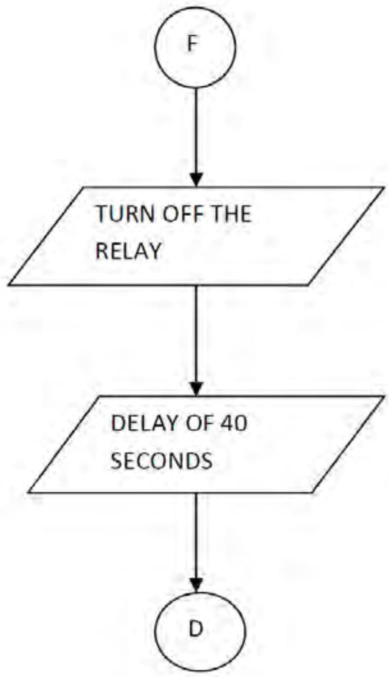
5.2 Program Flowchart:

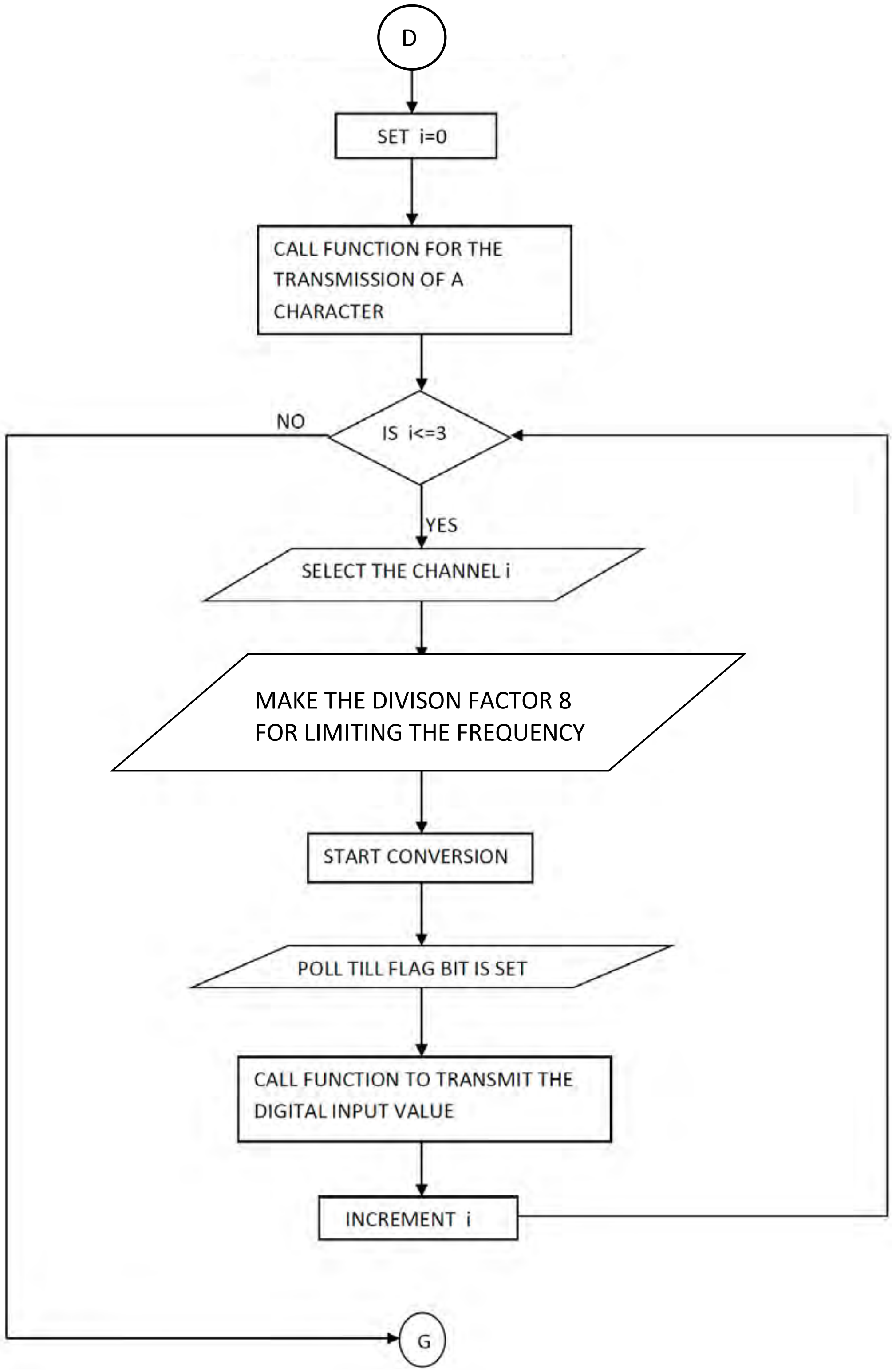


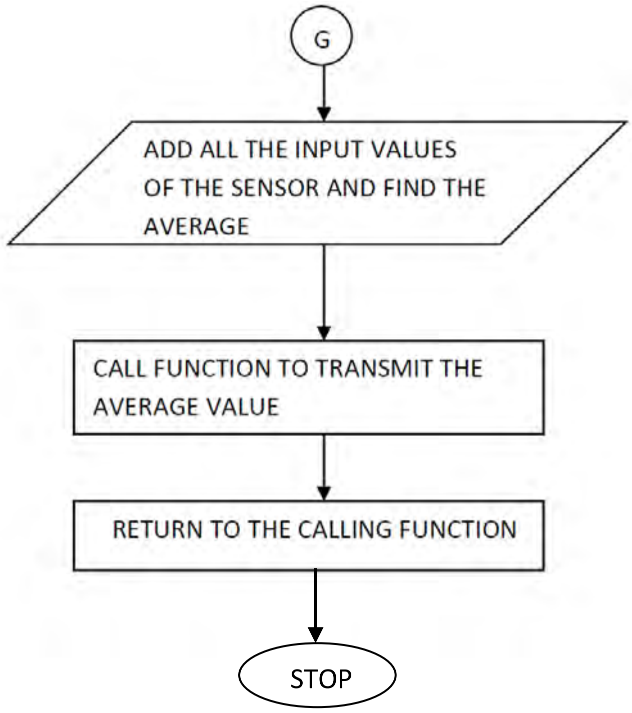

B
CALL FUNCTION FOR TRANSMISSION OF A CHARACTER
DELAY OF 20 SECONDS
TURN OFF THE RELAY
D


C
IS SENSOR AVERAGE <3V AND >=2V
NO
F
YES
TURN ON THE RELAY
CALL FUNCTION FOR TRANSMISSION OF A CHARACTER
E


E
DELAY OF 10 SECONDS
TURN OFF THE RELAY
D


F
TURN OFF THE RELAY
DELAY OF 40 SECONDS
D


D
SET i=0
CALL FUNCTION FOR THE TRANSMISSION OF A CHARACTER
NO
IS i<=3
YES
SELECT THE CHANNEL i
MAKE THE DIVISON FACTOR 8 FOR LIMITING THE FREQUENCY
START CONVERSION
POLL TILL FLAG BIT IS SET
CALL FUNCTION TO TRANSMIT THE DIGITAL INPUT VALUE
INCREMENT i
G


G
ADD ALL THE INPUT VALUES OF THE SENSOR AND FIND THE AVERAGE
CALL FUNCTION TO TRANSMIT THE AVERAGE VALUE
RETURN TO THE CALLING FUNCTION
STOP

Chapter 6: Conclusion & Importance of Sensors

6.1 Conclusion:

With the help of this project we have shown a prototype of the advanced model that can be used as automated irrigation system in the rural areas.

This model uses the sensors to find the moisture content of the soil, uses a temperature sensor to prevent the fire outbreak and provides alternate source of power by using the solar panels.

We believe that this project will help the farmers in the rural areas to increase their crop yield by modifying their farming techniques. They can rely on more reliable and renewable source of energy i.e. solar energy for running motors and other equipment in lieu of using the leased line power and setting up costly transformers for the area.

This report demonstrates how modern technology can be integrated with the traditional techniques of farming so that the resources are used wisely and judiciously.

This project has proved that the reductions in water use can range as high as 70% when compared to old farming practices.

6.1.1 Other possibilities:

Almost every sensing technique may find an application in agriculture and the food industry. The development of this technology is envisioned to provide revolutionary means for observing, assessing and controlling agricultural practices.

In agriculture and silviculture, as a branch of forestry, the need for increasing the production and simultaneously the efforts for minimizing the environmental impact and for saving costs make the sensor systems the best allied tool.

When nutrients in the soil, humidity, solar radiation, density of weeds and all factors affecting the production are known, this gets better and the use of chemical products such as fertilizers, herbicides and other pollution products can be reduced considerably.

6.1.2 Importance of soil moisture sensor:

We have shown the potential benefits of using soil moisture sensors for irrigation control which include water, energy, and fertilizer savings. By precisely controlling the water content of the substrate, it may be possible to expose plants to a mild, controlled drought stress to reduce:

(a) Stem elongation
(b) Water logging

6.1.3 Importance of solar energy:

This report has shown how the solar energy can be useful for powering the rural agricultural fields. We strongly believe that solar energy will provide:

- Reliable electricity to meet demand at peak processing times.
- Hedge against volatile electricity prices.
- Offset high electricity loads by producing on-site solar electric power.
- Clean energy.

6.1.4 Importance of temperature sensor:

The temperature sensing device called temperature sensor (LM35) is installed above the ground for keeping records of the temperature of environment. On the basis of which we control the opening/closing of the gate of Animal barn. Thus we have demonstrated that how we can save the animals from fire.

6.2 Conclusion of the proposed model:

This model enables:

- Production of healthy food and renewable resources of required quality.
- Reduction of human workload.
- Sustainable handling of natural sources.

Chapter 7: Advantages, Disadvantages and Applications, Future Scope

7.1 Advantages:

- Are relatively simple to design and install.
- This is very useful to all climatic conditions any it is economic friendly.
- This makes increase in productivity and reduces water consumption.
- Here we are using micro controllers so there is error free.
- This is safest and no manpower is required. Permit other yard and garden work to continue when irrigation is taking place, as only the immediate plant areas wet.
- Reduce soil erosion and nutrient leaching.
- Reduce the chance of plant disease by keeping foliage dry.
- May be concealed to maintain the beauty of the landscape, and to reduce vandalism and liability when installed in public areas.
- Require smaller water sources, for example, less than half of the water needed for a sprinkler system.
- The primary applications for this project are for farmers and gardeners who do not have enough time to water their crops/plants.
- It also covers those farmers who are wasteful of water during irrigation.
- The project can be extended to greenhouses where manual supervision is far and few in between.
- The principle can be extended to create fully automated gardens and farmlands.
- Combined with the principle of rain water harvesting, it could lead to huge water savings if applied in the right manner.
- In agricultural lands with severe shortage of rainfall, this model can be successfully applied to achieve great results with most types of soil.

The Microcontroller based irrigation system proves to be a real time feedback control system which monitors and controls all the activities of irrigation system efficiently. The present proposal is a model to modernize the agriculture industries on a small scale with optimum expenditure. Using this system, one can save manpower, water to improve production and ultimately profit.

7.2 Disadvantages:

Resistance blocks based sensors (soil moisture sensor) that have been used for this project are fairly accurate. Their major drawbacks are:

- Low resolution and hence limited use in research.
- Slow reaction time, i.e. when water is added, the sensor will take a while to arrive at the actual reading since it takes time for the water to seep through the soil.

- Temperature dependent. With changes in temperature there must be a compensation provided via the variable resistance in the signal conditioning board.
- The technique cannot be used to measure soil moisture around the saturation limits of the soil sample.

With the use of dielectric technique based sensors, all these drawbacks can be overcome. From the points mentioned above it is clear that a complete module of an upgraded smart irrigation system is a plausible and feasible enhancement option.

7.3 Applications:

7.3.1 Water Conservation and New Irrigation Technology:

Improving irrigation efficiency can contribute greatly to reducing production costs of vegetables, making the industry more competitive and sustainable. Through proper irrigation, average vegetable yields can be maintained (or increased) while minimizing environmental impacts caused by excess applied water and subsequent agrichemical leaching.

Recent technological advances have made soil water sensors available for efficient and automatic operation of irrigation systems. Automatic soil water sensor-based irrigation seeks to maintain a desired soil water range in the root zone that is optimal for plant growth. The target soil water status is usually set in terms of soil tension or matric potential (expressed in kPa or cbar, 1 kPa=1 cbar), or volumetric moisture (expressed in percent of water volume in a volume of undisturbed soil).

Another benefit of automatic irrigation techniques is convenience. In a previous experience working with a soil-moisture-based automatic irrigation system, it was found that once such a system is set up and verified, only weekly observation was required. This type of system adapts the amount of water applied according to plant needs and actual weather conditions throughout the season. This translates not only into convenience for the manager but into substantial water savings compared to irrigation management based on average historical weather conditions.

7.3.2 Soil Moisture Sensors for Manual Irrigation Control:

Although soil water status can be determined by **direct** (soil sampling) and **indirect** (soil moisture sensing) methods, direct methods of monitoring soil moisture are not commonly used for irrigation scheduling because they are intrusive and labor intensive and cannot provide immediate feedback.

Soil moisture probes can be permanently installed at representative points in an agricultural field to provide repeated moisture readings over time that can be used for irrigation management. Special care is needed when using soil moisture devices in coarse soils since most devices require close contact with the soil matrix that is sometimes difficult to achieve in these soils.

Depending on the quantity measured (i.e., volumetric water content or soil tension), indirect techniques are first classified into **volumetric** and **tensiometric.**

Most of the currently available volumetric sensors suitable for irrigation are dielectric. This group of sensors estimate soil water content by measuring the soil bulk permittivity (or dielectric constant) that determines the velocity of an electromagnetic wave or pulse through the soil.

In a composite material like the soil (i.e., made up of different components like minerals, air and water), the value of the permittivity is made up by the relative contribution of each of the components. Since the dielectric constant of liquid water is much larger than that of the other soil constituents, the total permittivity of the soil or bulk permittivity is mainly governed by the presence of liquid water.

7.4 Future Scope of Project:

The key elements that can be considered while designing an advanced mechanical model are:

7.4.1 Flow:

We can measure the output of water supply with a one or five gallon bucket and a stopwatch. Time how long it takes to fill the bucket and use that number to calculate how much water is available per hour.

Gallons per minute x 60=number of gallons per hour.

7.4.2 Pressure (The force pushing the flow):

Most products operate best between 20 and 40 pounds of pressure. **Normal household pressure is 40-50 pounds.**

7.4.3 Water Supply & Quality:

City and well water are easy to filter for drip irrigation systems. Pond, ditch and some well water have special filtering needs. The quality and source of water will dictate the type of filter necessary for our system.

7.4.4 Soil Type and Root Structure:

The soil type will dictate how a regular drip of water on one spot will spread. Sandy soil requires closer emitter spacing as water percolates vertically at a fast rate and slower horizontally. With a clay soil water tends to spread horizontally, giving a wide distribution pattern.

Emitters can be spaced further apart with clay type soil. A loamy type soil will produce a more even percolation dispersion of water. Deep-rooted plants can handle a wider spacing of emitters, while shallow rooted plants are most efficiently watered slowly (low gap emitters) with emitters spaced close together. On clay soil or on a hillside, short cycles repeated frequently work best. On sandy soil, applying water with higher gap emitters lets the water spread out horizontally better than a low gap emitter.

7.4.5 Elevation:

Variations in elevation can cause a change in water pressure within the system. Pressure changes by one pound for every 2.3 foot change in elevation. Pressure-compensating emitters are designed to work in areas with large changes in elevation.

7.4.6 Timing:

Watering in a regular scheduled cycle is essential. On clay soil or hillsides, short cycles repeated frequently work best to prevent runoff, erosion and wasted water. In sandy soils, slow watering is recommended. Sensors help prevent the too-dry/too-wet cycles that stress plants and retard their growth.

7.4.7 Watering Needs:

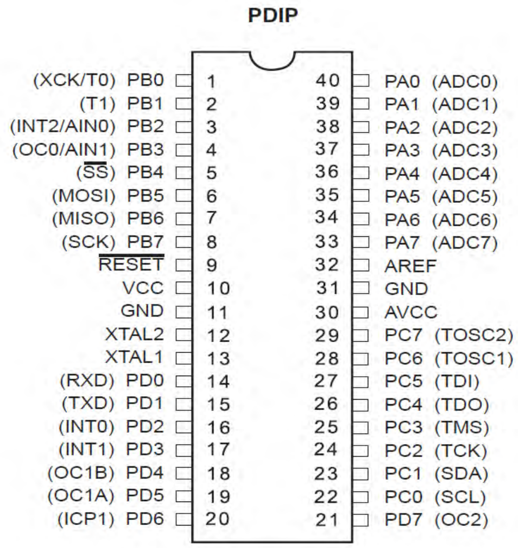
- Plants with different water needs may require their own watering circuits. For example, orchards that get watered weekly need a different circuit than a garden that gets watered daily. Plants that are drought tolerant will need to be watered differently than plants requiring a lot of water. Thus we can use different sensor circuits. Having taken all these additional variables into account, we can design and implement a Smart Irrigation System for the growing needs of farmers in the future.
- Usage of drip irrigation system is also a huge boost for later enhancements since it is the most sought after, when it comes to irrigation. When compared with overhead sprinkler systems, this irrigation system leads to less soil and wind erosion. This irrigation system can be applied under a wide range of field conditions.

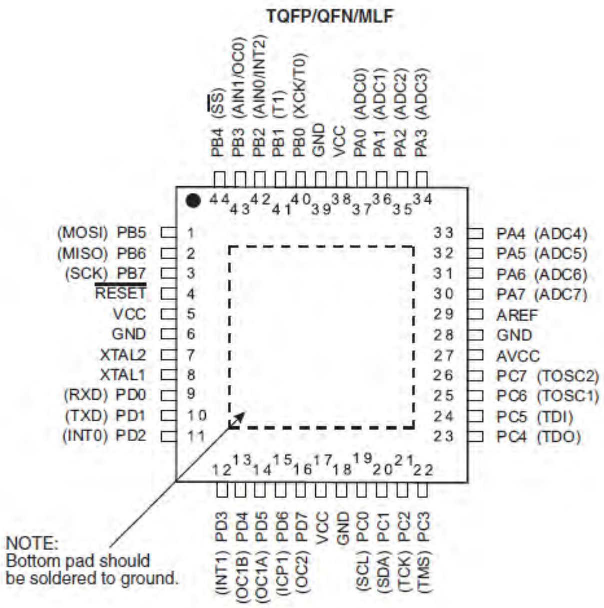
Appendix

This part of the report contains the datasheets of the various components used in the model. Also the necessary explanation about the construction and working of the components is also given in some sections.

1. Microcontroller (ATmega32):

1.1 Pin Configurations (fig 1):





1.2 Overview:

The ATmega16 is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega16 achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

1.3 Block Diagram:

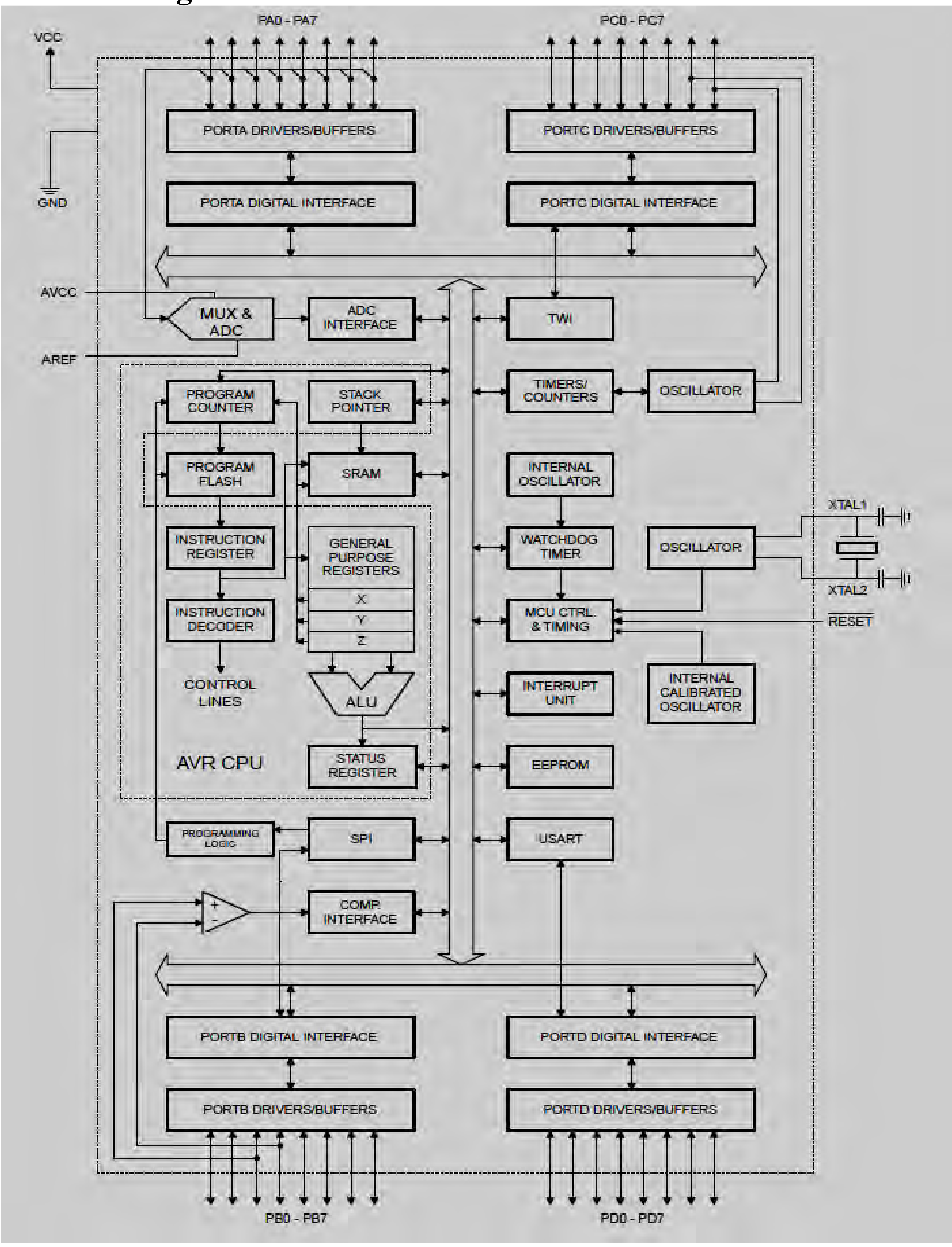


Fig 2: Block Diagram of ATmega32

- The Atmel® AVR® core combines a rich instruction set with 32 general purpose working registers. All the 32 registers are directly connected to the Arithmetic Logic Unit (ALU), allowing two independent registers to be accessed in one single instruction executed in one clock cycle. The resulting architecture is more code efficient while achieving throughputs up to ten times faster than conventional CISC microcontrollers.

- The device is manufactured using Atmel's high density nonvolatile memory technology. The on chip ISP Flash allows the program memory to be reprogrammed in-system through an SPI serial interface, by a conventional nonvolatile memory programmer, or by an On-chip Boot program running on the AVR core. The boot program can use any interface to download the application program in the Application Flash memory. Software in the Boot Flash section will continue to run while the Application Flash section is updated, providing true Read-While-Write operation.

- By combining an 8-bit RISC CPU with In-System Self-Programmable Flash on a monolithic chip, the Atmel ATmega32 is a powerful microcontroller that provides a highly-flexible and cost-effective solution to many embedded control applications. The Atmel AVR ATmega32 is supported with a full suite of program and system development tools including: C compilers, macro assemblers, program debugger/simulators, in-circuit emulators, and evaluation kits.

1.4 Pin Descriptions:

1.4.1 VCC: Digital supply voltage.

1.4.2 GND: Ground.

1.4.3 Port A (PA7-PA0):

Port A serves as the analog inputs to the A/D Converter. Port A also serves as an 8-bit bi-directional I/O port, if the A/D Converter is not used. Port pins can provide internal pull-up resistors (selected for each bit). The Port A output buffers have symmetrical drive characteristics with both high sink and source capability. When pins PA0 to PA7 are used as inputs and are externally pulled low, they will source current if the internal pull-up resistors are activated. The Port A pins are tri-stated when a reset condition becomes active, even if the clock is not running.

1.4.4 Port B (PB7-PB0):

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port B output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, even if the clock is not running. Port B also serves the functions of various special features of the ATmega16.

1.4.5 Port C (PC7-PC0):

Port C is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port C output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The Port C pins are tri-stated when a reset condition becomes active, even if the clock is not running. If the JTAG interface is enabled, the pull-up resistors on pins PC5 (TDI), PC3 (TMS) and PC2 (TCK) will be activated even if a reset occurs.

1.4.6 Port D (PD7-PD0):

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for each bit). The Port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port D pins that are externally pulled low will source current if the pull-up resistors are activated. The Port D pins are tri-stated when a reset condition becomes active, even if the clock is not running.

1.4.7 Reset:

Reset Input. A low level on this pin for longer than the minimum pulse length will generate a reset, even if the clock is not running. Shorter pulses are not guaranteed to generate a reset.

1.4.8 XTAL1:

Input to the inverting Oscillator amplifier and input to the internal clock operating circuit.

1.4.9 XTAL2: Output from the inverting Oscillator amplifier.

1.4.10 AVCC:

AVCC is the supply voltage pin for Port A and the A/D Converter. It should be externally connected to VCC, even if the ADC is not used. If the ADC is used, it should be connected to VCC through a low-pass filter.

1.4.11 AREF: AREF is the analog reference pin for the A/D Converter.

2. Voltage Regulator: 78xx (7805 is used in this project)

3-Terminal 1.5A Positive Voltage Regulator

2.1 Features:

- Output Current up to 1.5A
- Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24V

- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection

2.2 Description:

This series of fixed-voltage integrated-circuit voltage regulators is designed for a wide range of applications. These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation. Each of these regulators can deliver up to 1.5 A of output current. The internal current-limiting and thermal-shutdown features of these regulators essentially make them immune to overload. In addition to use as fixed-voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents, and also can be used as the power-pass element in precision regulators.

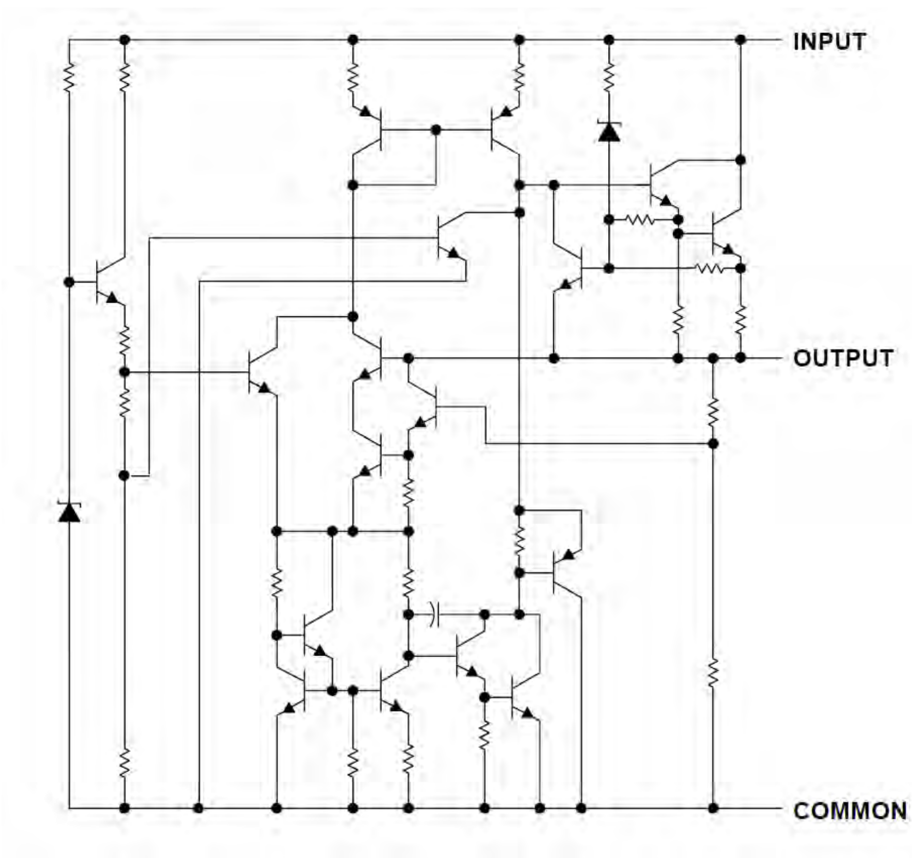
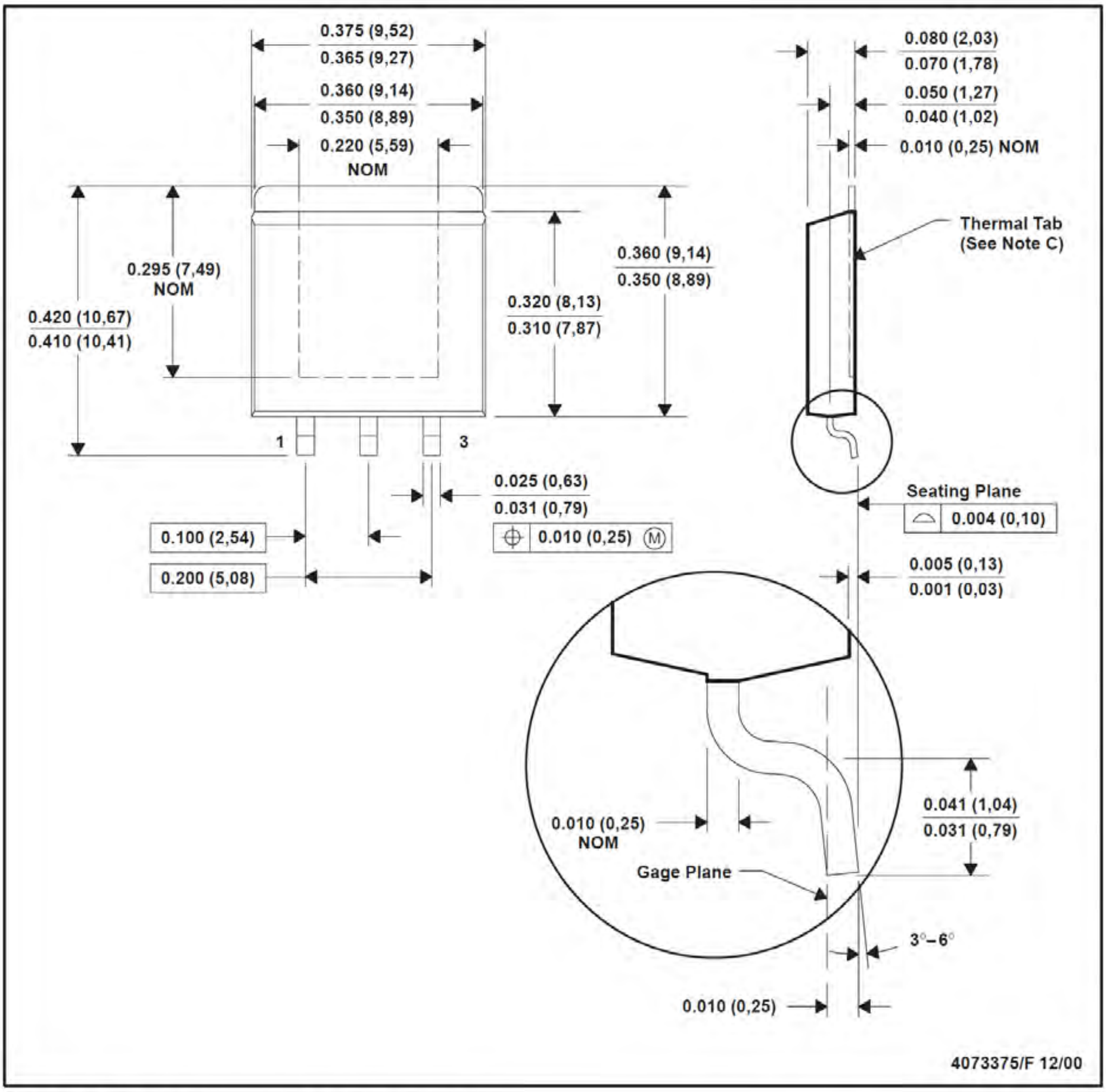


Fig 3: Schematic of Voltage Regulator

2.3 Absolute maximum ratings over virtual junction temperature range:

Input voltage, V_I:	μA7824C	40 V
	All others	35 V
Operating virtual junction temperature, T_J		150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds		260°C
Storage temperature range, T_{stg}		–65°C to 150°C

2.4 Physical Dimensions:



NOTES:
- A. All linear dimensions are in inches (millimeters).
- B. This drawing is subject to change without notice.
- C. The center lead is in electrical contact with the thermal tab.
- D. Dimensions do not include mold protrusions, not to exceed 0.006 (0,15).
- E. Falls within JEDEC MO-169

Fig 4: Measurements of KTE Plastic Flange-mount Mode

3. ULN2003:

3.1 Description:

The ULN2003 is a monolithic high voltage and high current Darlington transistor arrays. It consists of seven NPN Darlington pairs that features high-voltage outputs with common-cathode clamp diode for switching inductive loads. The collector-current rating of a single Darlington pair is 500mA. The Darlington pairs may be paralleled for higher current capability. Applications include relay drivers, hammer drivers, lamp drivers, display drivers (LED gas discharge), line drivers, and logic buffers. The ULN2003 has a 2.7kW series base resistor for each Darlington pair for operation directly with TTL or 5V CMOS devices.

3.2 Features:

- 500mA rated collector current (Single output)
- High-voltage outputs: 50V
- Inputs compatible with various types of logic.
- Relay driver application

3.3 Schematic (each Darlington pair):

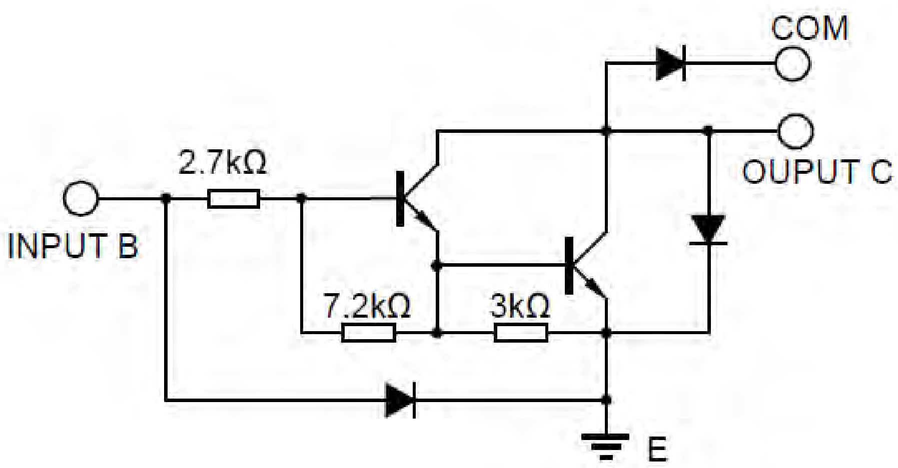


Fig 5: Each Darlington Pair

3.4 Absolute maximum ratings:

ABSOLUTE MAXIMUM RATINGS(Ta=25°C)

Characteristic	Symbol	Value	Unit
Colletor-Emitter Voltage	V_{CE}	50	V
Input Voltage	V_I	30	A
Peak Collector Current	Io	500	mA
Total Emitter-terminal	IOK	500	mA
Power Dissipation	Pd	950 Tamb=25°C 495 Tamb<85°C	mW mW
Operating Temperature	Topr	-20~ +85	°C
Storage Temperature	Tstg	-65 ~ +150	°C

Note: All volatge values are with repect to the emitter/substrate terminal E, unless otherwise noted.

Fig 6: Absolute Maximum Ratings

3.5 Typical performance characteristics:

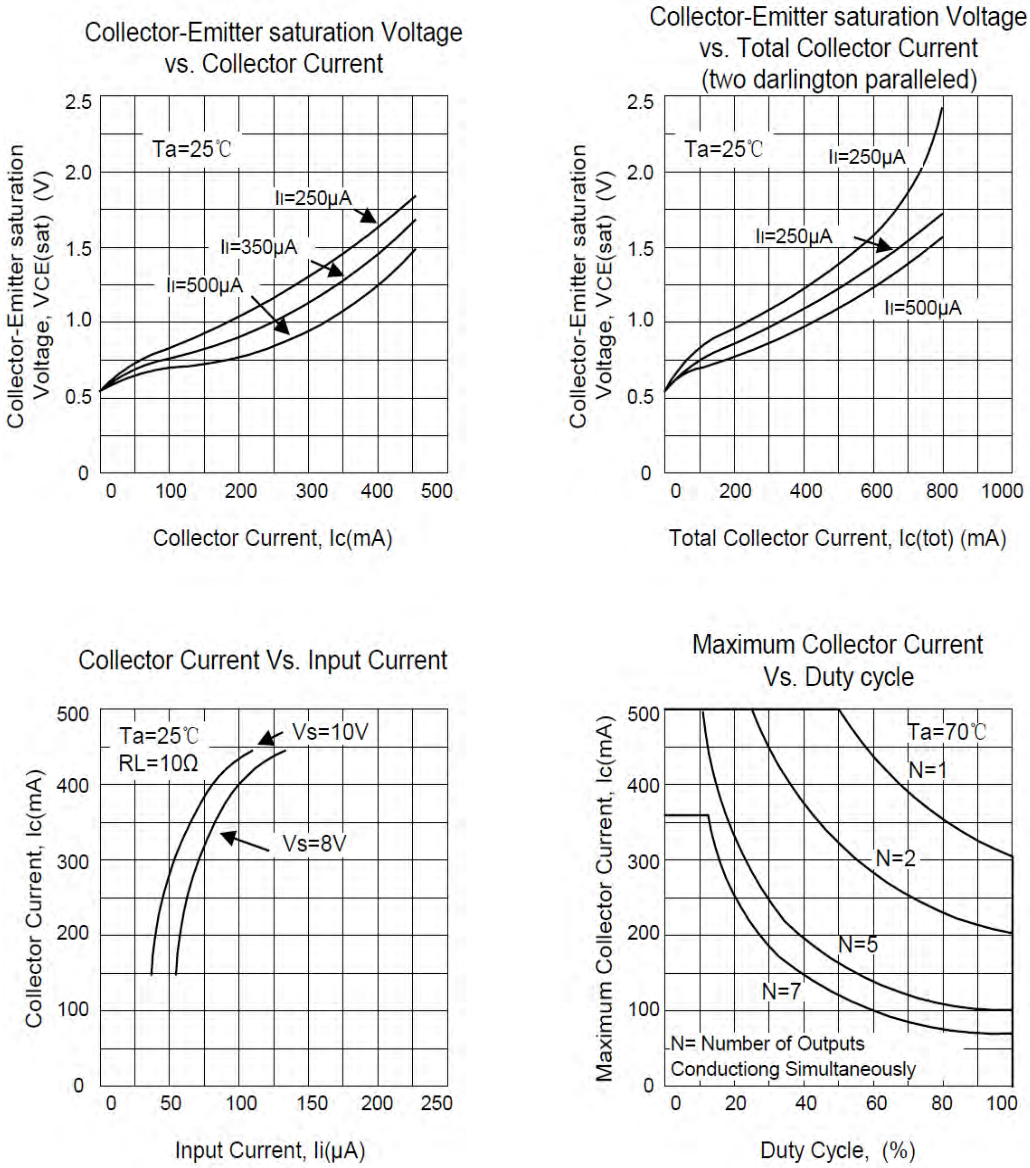


Fig 7: Typical Performance Characteristics

4. Temperature sensor (LM35):

4.1 General description:

- The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling.

- The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range.

- Low cost is assured by trimming and calibration at the wafer level.

- The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air.

- The LM35 is rated to operate over a −55° to +150°C temperature range, while the LM35C is rated for a −40° to +110°C range (−10° with improved accuracy).

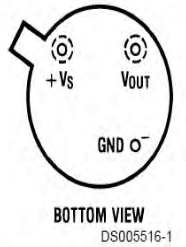
- The LM35 series is available packaged in hermetic TO-46 transistor packages, while the LM35C, LM35CA, and LM35D are also available in the plastic TO-92 transistor package. The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

4.2 Features:

- Calibrated directly in ° Celsius (Centigrade)
- Linear + 10.0 mV/°C scale factor
- 0.5°C accuracy guaranteeable (at +25°C)
- Rated for full −55° to +150°C range
- Suitable for remote applications
- Low cost due to wafer-level trimming
- Operates from 4 to 30 volts
- Less than 60 µA current drain
- Low self-heating, 0.08°C in still air
- Nonlinearity only ±1⁄4°C typical
- Low impedance output, 0.1 W for 1 mA load

4.3 Connection diagrams:

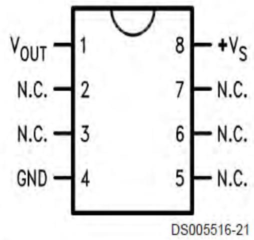
TO-46
Metal Can Package*



*Case is connected to negative pin (GND)

Order Number LM35H, LM35AH, LM35CH, LM35CAH or LM35DH
See NS Package Number H03H

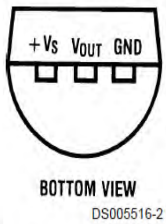
SO-8
Small Outline Molded Package



N.C. = No Connection

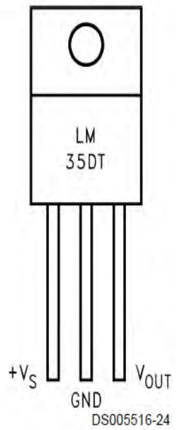
Top View
Order Number LM35DM
See NS Package Number M08A

TO-92
Plastic Package



Order Number LM35CZ, LM35CAZ or LM35DZ
See NS Package Number Z03A

TO-220
Plastic Package*



*Tab is connected to the negative pin (GND).
Note: The LM35DT pinout is different than the discontinued LM35DP.

Order Number LM35DT
See NS Package Number TA03F

Fig 8: Connection Diagrams

4.4 Block diagram:

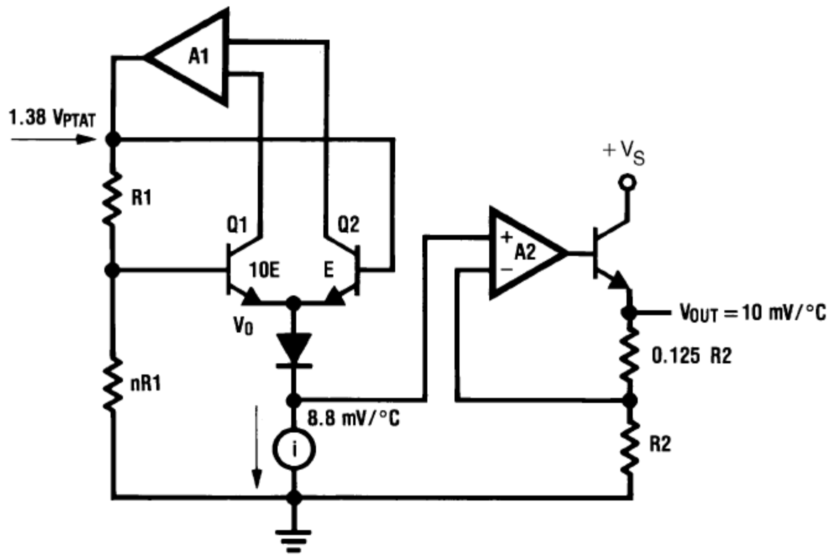
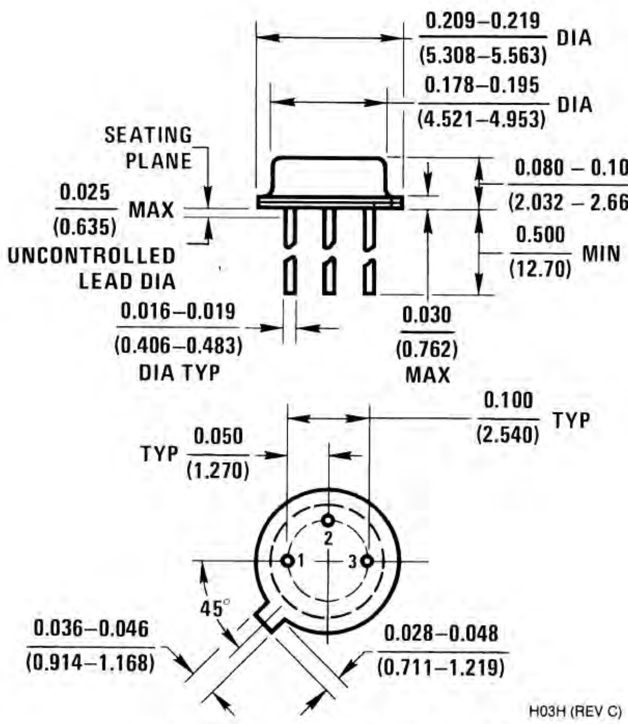
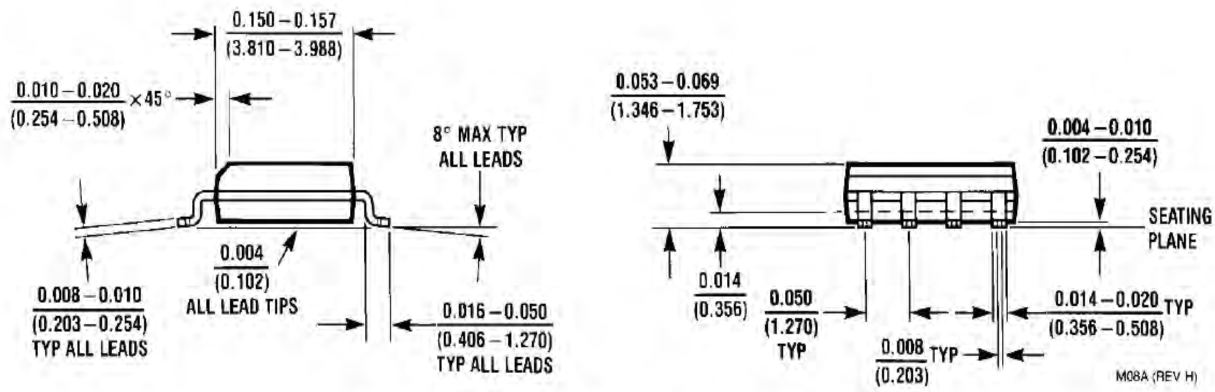


Fig 9: Block Diagram of LM35

4.5 Physical dimensions:



TO-46 Metal Can Package (H)
Order Number LM35H, LM35AH, LM35CH, LM35CAH, or LM35DH
NS Package Number H03H



SO-8 Molded Small Outline Package (M)
Order Number LM35DM
NS Package Number M08A

Fig 10: Physical Dimensions (inches (millimeters), unless otherwise stated)

4.6 Typical performance characteristics:

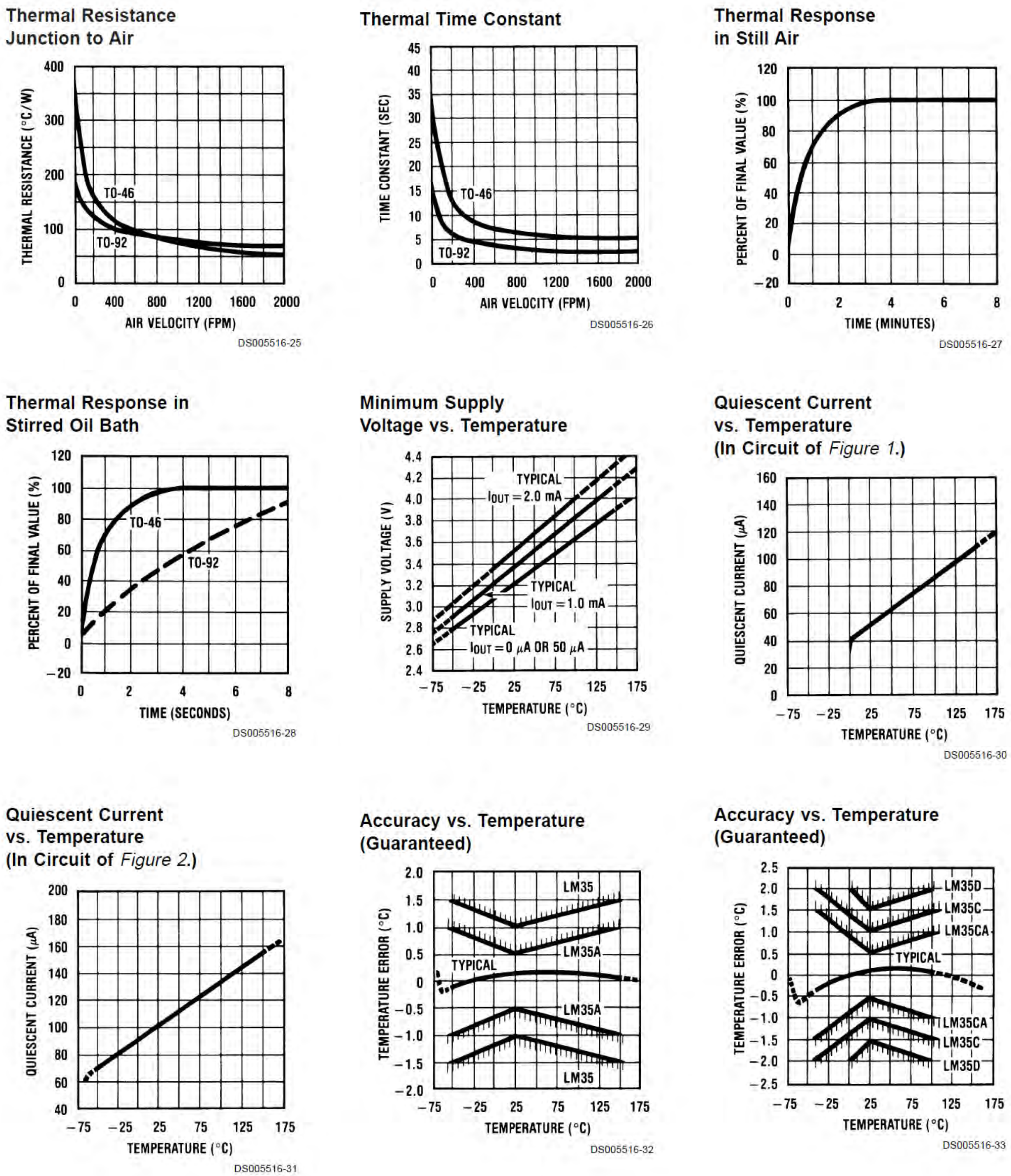


Fig 11: Typical Performance Characteristics

4.7 Absolute maximum ratings:

Supply Voltage	+35V to −0.2V
Output Voltage	+6V to −1.0V
Output Current	10 mA
Storage Temp.;	
TO-46 Package,	−60°C to +180°C
TO-92 Package,	−60°C to +150°C
SO-8 Package,	−65°C to +150°C
TO-220 Package,	−65°C to +150°C
Lead Temp.:	
TO-46 Package, (Soldering, 10 seconds)	300°C
TO-92 and TO-220 Package, (Soldering, 10 seconds)	260°C
SO Package (Note 12)	
Vapor Phase (60 seconds)	215°C
Infrared (15 seconds)	220°C
ESD Susceptibility (Note 11)	2500V
Specified Operating Temperature Range: T_{MIN} to T_{MAX} (Note 2)	
LM35, LM35A	−55°C to +150°C
LM35C, LM35CA	−40°C to +110°C
LM35D	0°C to +100°C

Fig 12: Absolute Maximum Ratings

4.8 Typical applications:

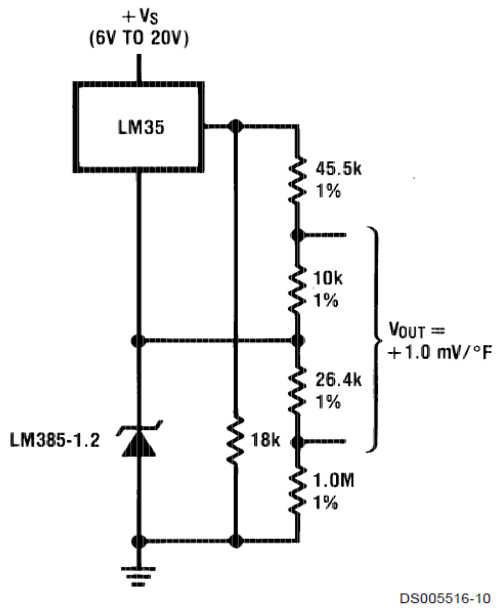


Fig 13.1: Fahrenheit Thermometer

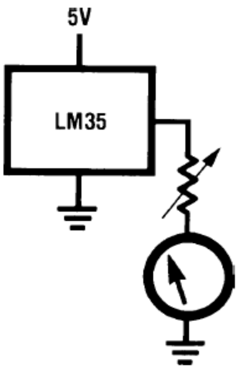


Fig 13.2: Centigrade Thermometer

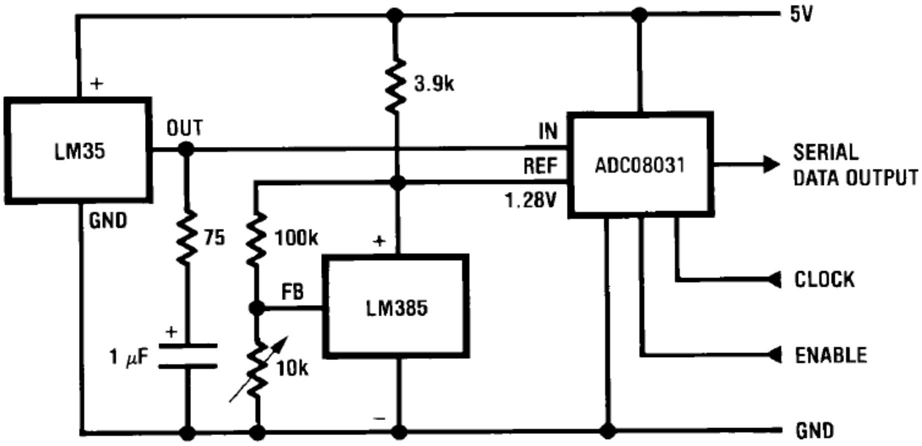


Fig 13.3: Temperature To Digital Converter (serial output) (+128°C Full Scale)

5. Liquid Crystal Display (LCD) (16x2):

The LCD used is the one with16x2 characters display. The pin diagram for it is as shown below:

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
VSS	VCC	VEE	RS	R/W	E	DB0	DB1	DB2	DB3	DB4	DB5	DB6	DB7	LED+	LED-

Fig 14: Pin Description for LCD

- **VSS:** This pin is connected to the ground.
- **VCC:** This is the pin where power supply is provided to the LCD.
- **VEE:** A variable resistor is connected at this pin and is used to control the contrast of the LCD.

- **RS: Register select:** If RS =0, the instruction command code register is selected, allowing the user to send a command such as clear display, cursor at home etc. If RS=1, the data register is selected allowing the user to send data to be displayed on the LCD.
- **R/W: Read or Write:** If R/W=1 then data on the data bus is read while when R/W=0 then data is written to the data lines of the LCD.
- **E: Enable:** The Enable pin is used by LCD to latch information presented to its data pins. When data is supplied to data pins, a high to low pulse must be applied to this pin in order for the LCD to latch in the data present at the data pins.
- **DB0-DB7:** These eight pins are the data pins of the LCD.

6. Crystal Oscillator:

- A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency.
- This frequency is commonly used to keep track of time (as in quartz wrist watches), to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers.
- The most common type of piezoelectric resonator used is the quartz crystal, so oscillator circuits incorporating them became known as crystal oscillators, but other piezoelectric materials including polycrystalline ceramics are used in similar circuits.
- Quartz crystals are manufactured for frequencies from a few tens of kilohertz to tens of megahertz. More than two billion crystals are manufactured annually. Most are used for consumer devices such as wristwatches, clocks, radios, computers, and cell phones. Quartz crystals are also found inside test and measurement equipment, such as counters, signal generators, and oscilloscopes.

7. Screenshots of the Software Used:

The general CVAVR window looks like this:

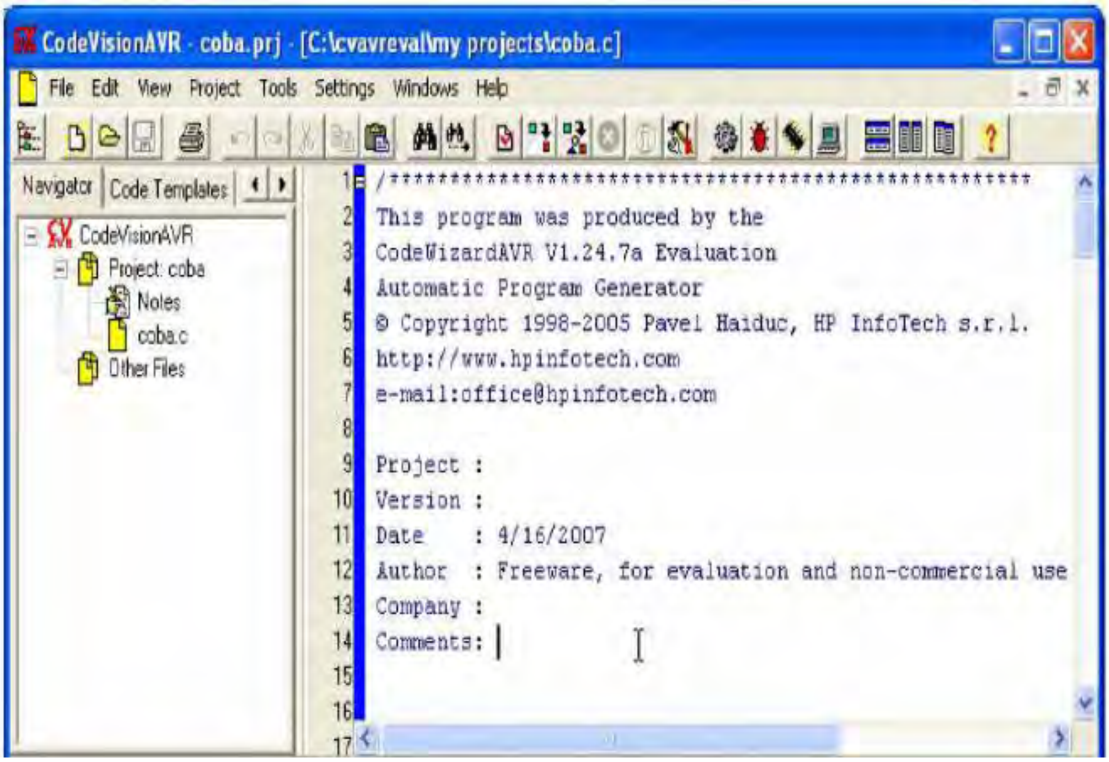


Fig 15: General CVAVR Window

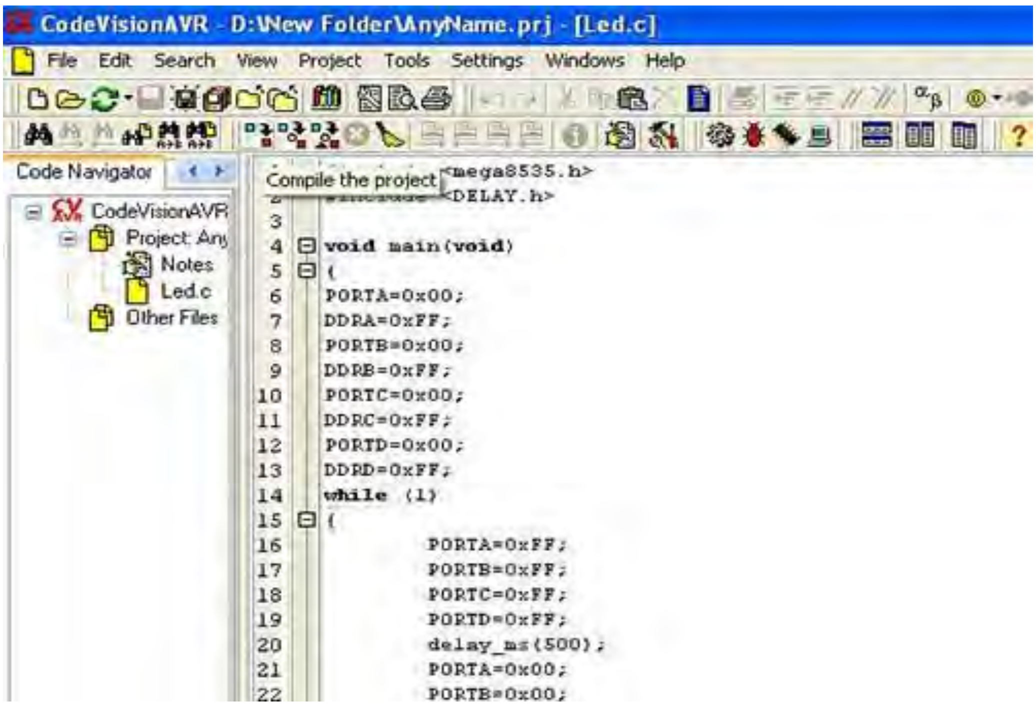


Fig 16: Compiling a Program in CVAVR

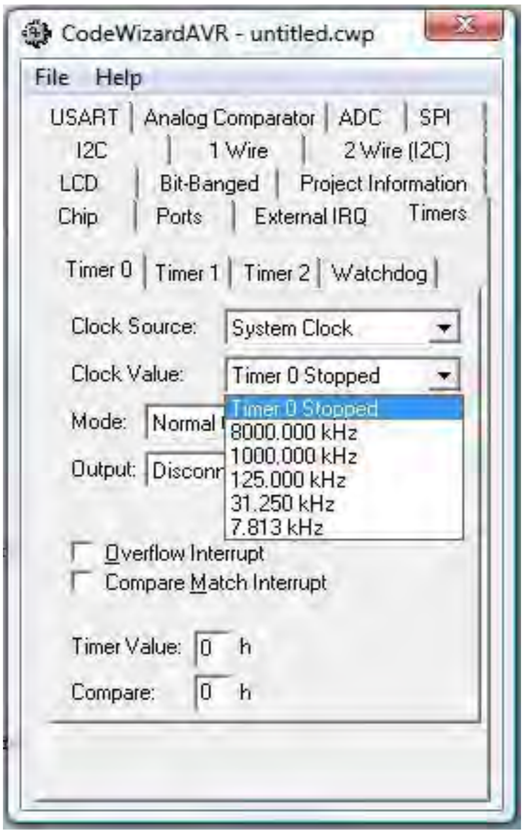


Fig 17: Setting the Timers

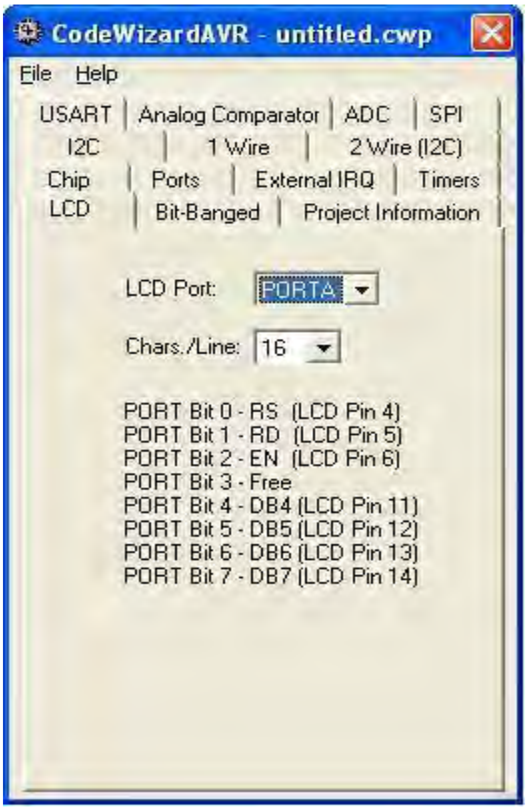


Fig 18: Port Selection for LCD

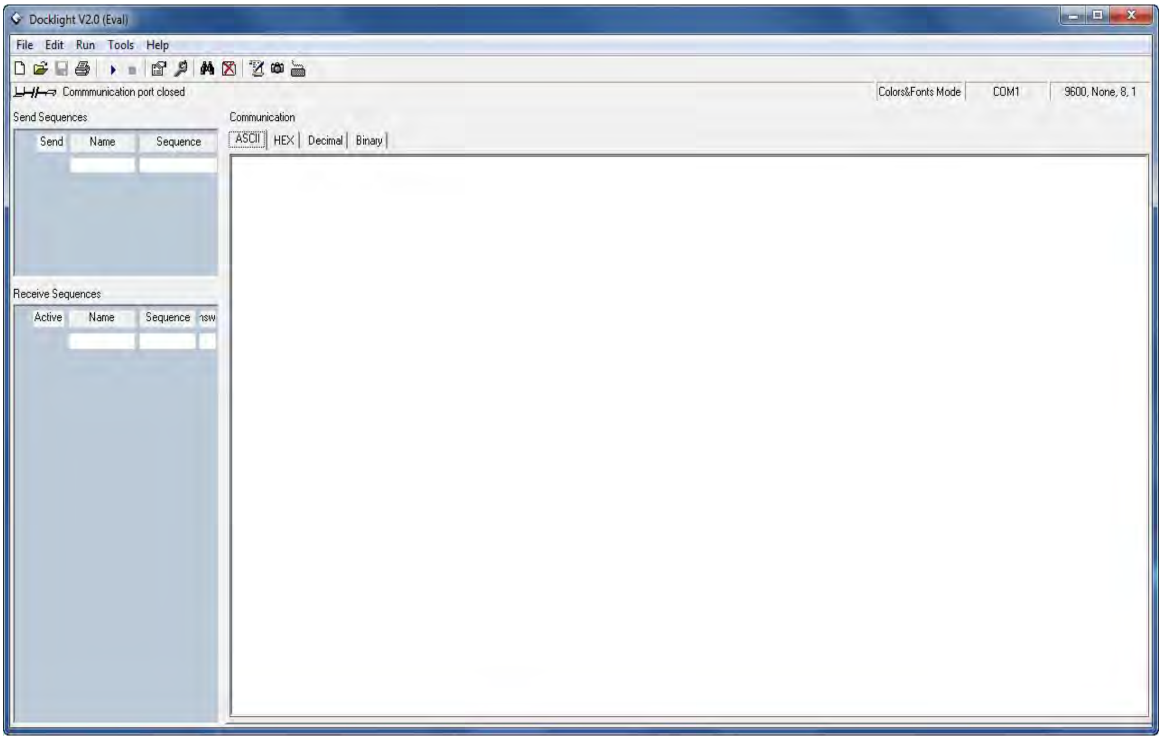


Fig 19: Docklight Window

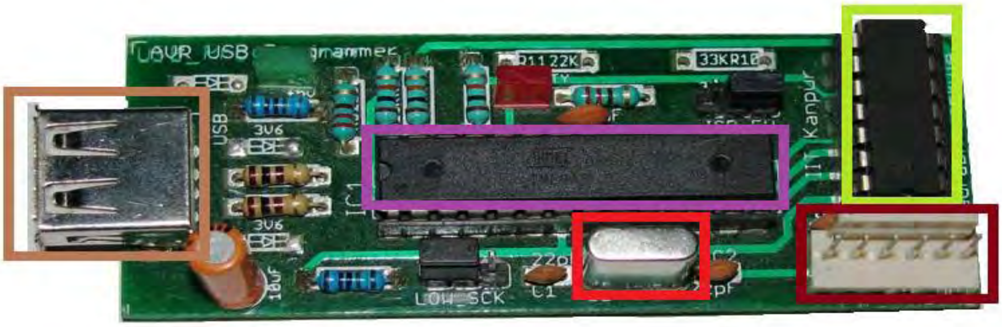


Fig 20: A USB Programmer for Programming the µC

References

The making of the model utilizes data from various sites and research papers. Some of these include:

1. **IEEE website**
   http://www.ieee.org

2. **Wikipedia**
   http://en.wikipedia.org/wiki/Main_Page

3. **Texas instruments**
   http://www.ti.com/

4. **ATmega microcontroller**
   http://www.atmel.com/products/microcontrollers/avr/default.aspx